MEGBI - Middle East Genetics
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مركز أبحاث للجينات والتقنية البيولوجية
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Control System of Antibiotics Production Pilot Plant (MEGBI-APP)

Version 2020

Developers & Operation Manual

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System Overview

HMI

PLC

Electrical system

Periphery: Actuators & Sensors

Electric Mixer

Temp sensor1 (Thermocouple k)

Actuator Valve1

Actuator Valve2 Solenoid valve

Pump

Temp sensor 2 (Thermocouple k)

Pressure sensor

Resistor of Heater

1 Hardware and Development Environment

1.1 Human Machine Interface (DOP107-BV)

A human machine interface (HMI) is a platform which permits interaction between users and automation equipment.

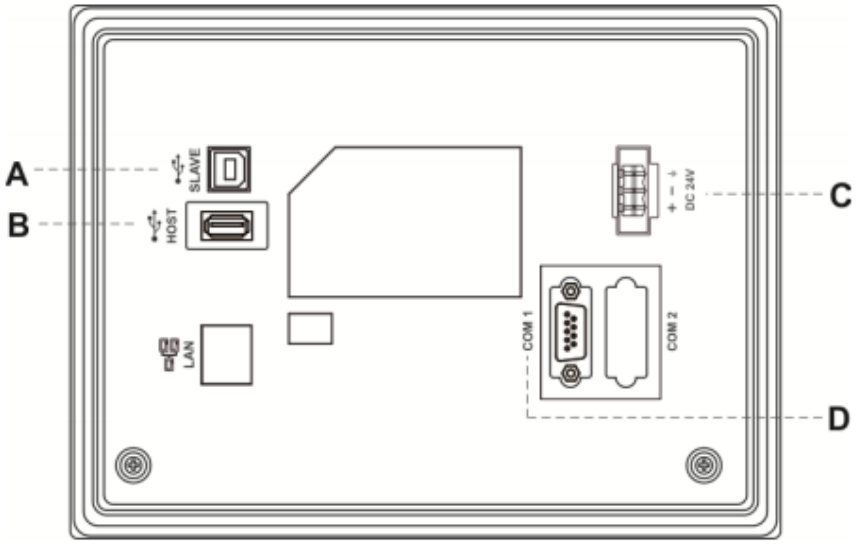
The HMI adopt the latest Cortex-A8 / Dual Core high-speed processor and 65,536 color LCD screen with high brightness and contrast. In addition, they are equipped with the HMI programming software DOPSoft 4.0 and built-in Lua editor for easy programming as well as alarm / history log / user authority functions for highly efficient management.

1.1.1 Specifications

Model		DOP-107BV
Display	Panel type	7" TFT LCD (65535 colors)
	Resolution	800 x 480 pixels
	Backlight	LED backlight (half-life under room temperature 25°C > 20,000 hours)*1
	Display range	154.08 mm * 85.92 mm
	Brightness	400 cd / m² (Typ.)
CPU		ARM Cortex-A8 (800 MHz)
Flash ROM		256 Mbytes
RAM		256 Mbytes
Touchscreen		4-wire resistive touchscreen > 1,000,000 operated
Buzzer		Multi-tone frequency (2 K – 4 KHz) / 80 dB
Network interface		N/A
USB		1 USB Slave Ver 2.0; 1 USB Host Ver 2.0
SD		N/A
Serial communication port	COM1	RS-232 (supporting flow control) / RS-485*2
	COM2	RS-422 / RS-485*2
	COM3	N/A
Auxiliary function key		N/A
Calendar		Built-in
Cooling method		Natural cooling
Approvals		CE / UL (please use shielding network cable and magnetic ring with the filter of 300 ohm / 100 MHz)
Panel waterproof level		IP65 / NEMA4 / UL TYPE 4X (indoor use only)
Operation voltage*2		DC +24V (-15% to +15%) (please use an isolated power supply) Supplied by Class 2 or SELV circuit (isolated from MAINS by double insulation)
Leakage current		500 V_{AC} for 1 minute (between DC24V terminal and FG terminal)
Power consumption*2		8.6 W (Max)*3
Backup battery		3V lithium battery CR2032 × 1
Backup battery life		About 3 years or more at 25°C (subject to operation temperature and condition)
Operation temperature		0°C to 50°C (32°F to 122°F)
Storage temperature		-20°C to +60°C (-4°F to 140°F)
Operating environment		10% - 90% RH [0°C - 40°C], 10% - 55% RH [41°C - 50°C]; pollution degree: 2
Vibration resistance		Conforms to IEC61131-2: continuous vibration 5 Hz - 8.3 Hz with amplitude 3.5 mm; 8.3 Hz - 150 Hz with amplitude 1G
Shock resistance		Conforms to IEC60068-2-27: 11 ms, 15 G Peak, in X, Y, Z directions each for 6 times
Dimension (W) x (H) x (D) mm		215 x 161 x 35.5
Mounting dimension (W) x (H) mm		196.9 x 142.9
Weight		Approx. 700 g

1.1.2 Descripton

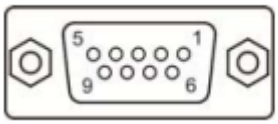
DOP-107BV (rear view)



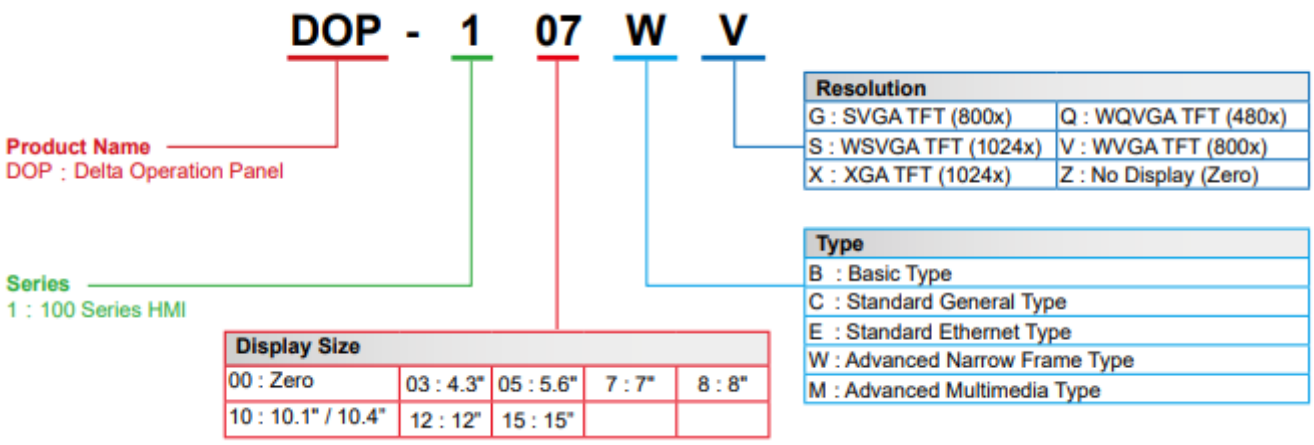
A	USB Slave	B	USB Host
C	Power input terminal (24 AWG wire min.)	D	COM1

1.1.3 Communication port pin assignment

DOP-107BV COM1

COM Port	Pin	MODE1		MODE2		MODE3	
		COM1	COM2	COM1	COM2	COM1	COM2
		RS-232	RS-485	RS-485	RS-485	RS-232	RS-422
	1	-	-	D+	-	-	TXD+
	2	RXD	-	-	-	RXD	-
	3	TXD	-	-	-	TXD	-
	4	-	D+	-	D+	-	RXD+
	5	GND		GND		GND	
	6	-	-	D-	-	-	TXD-
	7	RTS	-	-	-	RTS	-
	8	CTS	-	-	-	CTS	-
	9	-	D-	-	D-	-	RXD-

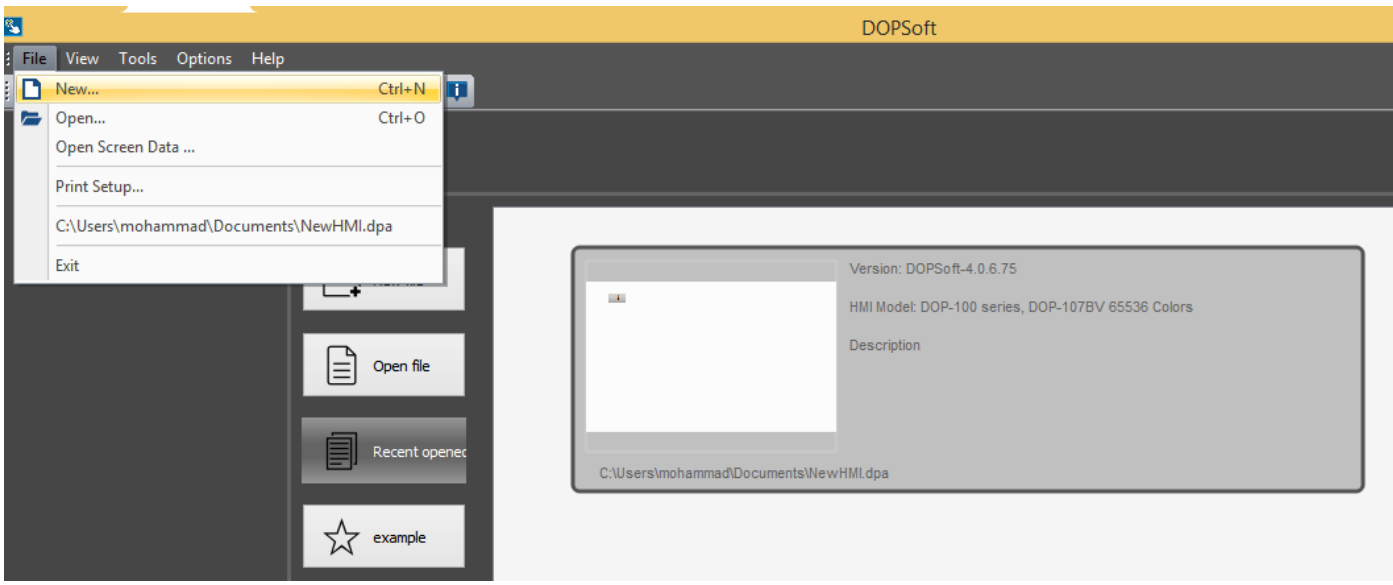
1.1.4 Model Description



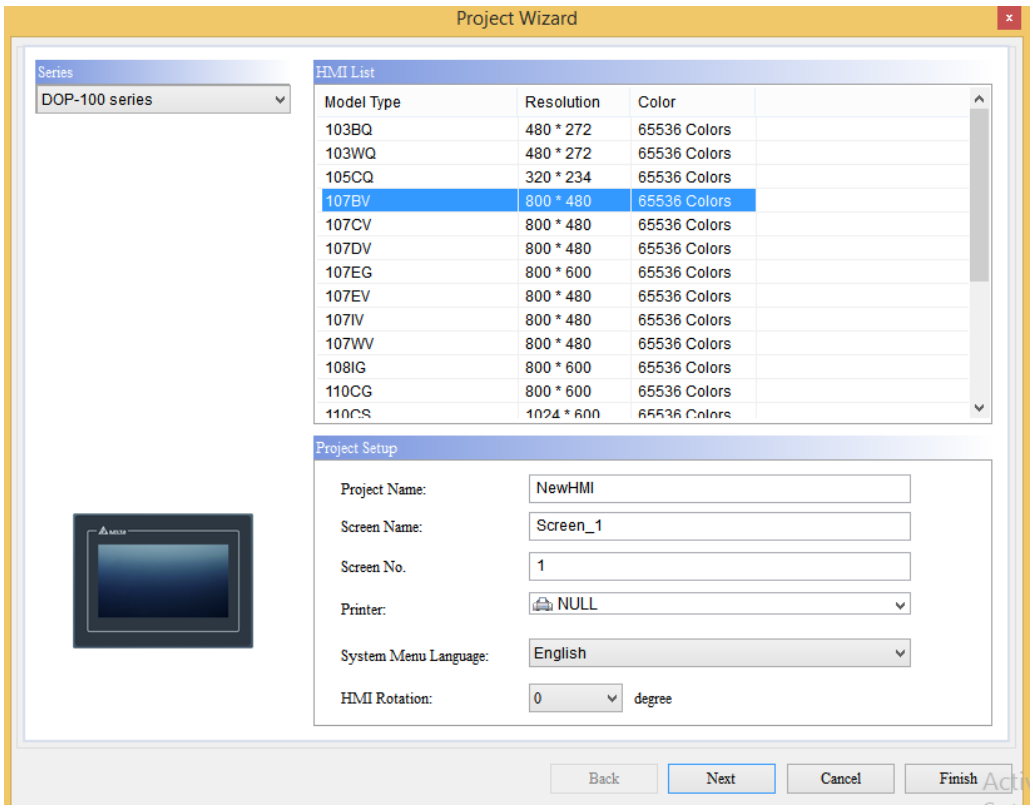
1.1.5 Software DOPSoft 4.0 for HMI programming

1.1.5.1 Create a Project

- We click on «File-New »



- We choose the HMI product «107BV »
- We put a name in the «Project Name»
- We click on «Next »



- **We choose the following :**

  Port of communication « COM1 »

  Manufacturers : « Delta »

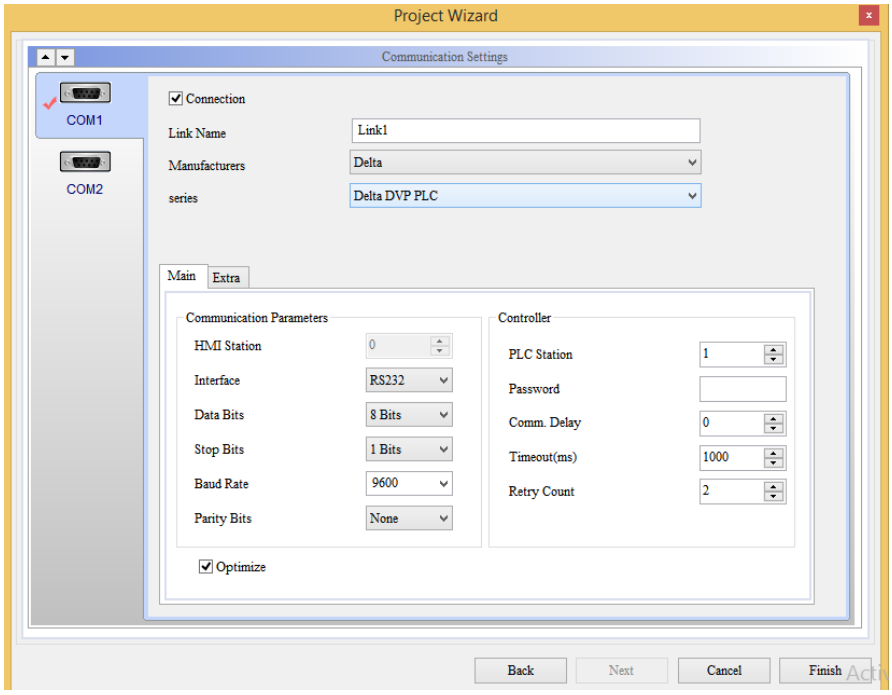
  Series : « Delta DVP PLC »

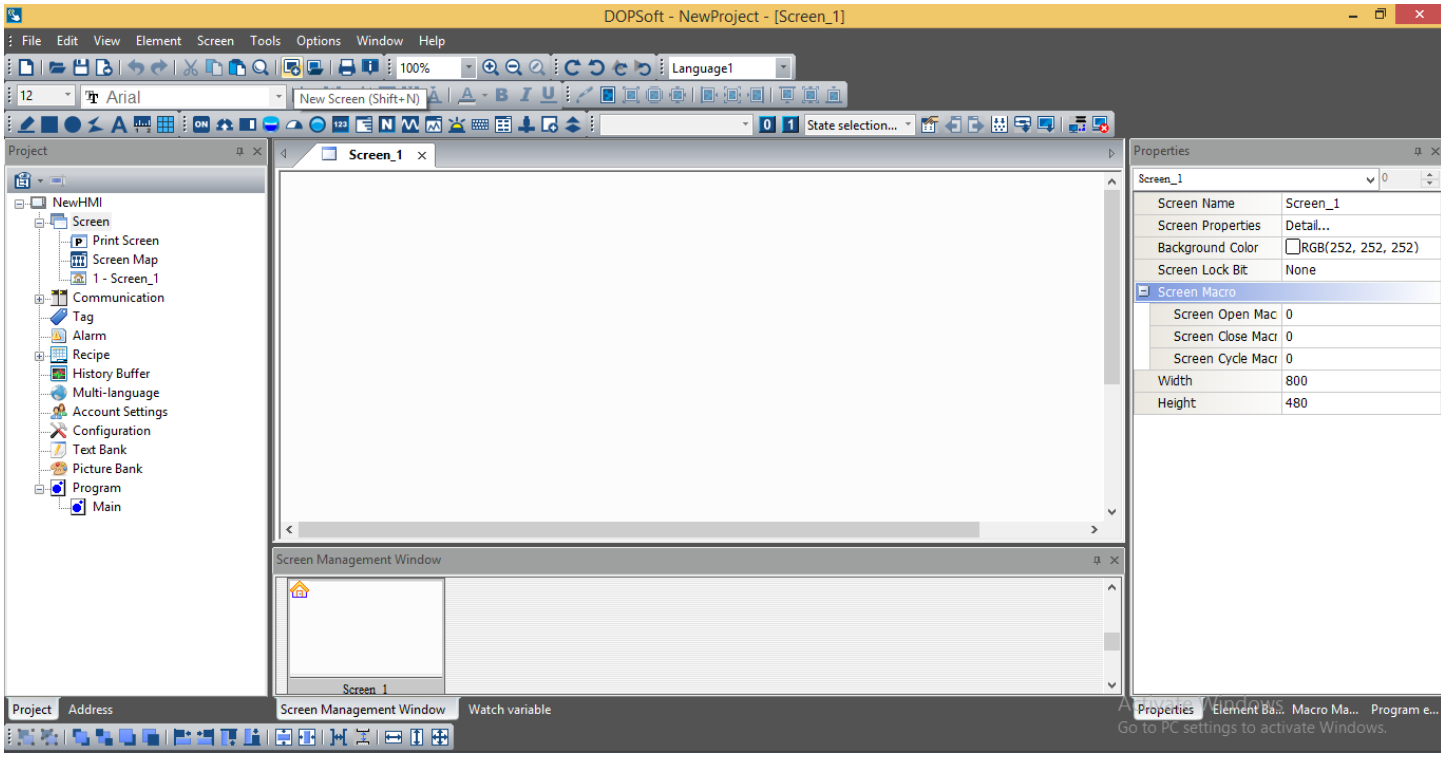
  Address of PLC Station : « 1 »

  Interface : « RS232»

  We choose the "communication parameters" that correspond to the PLC

- We click on «Finish »

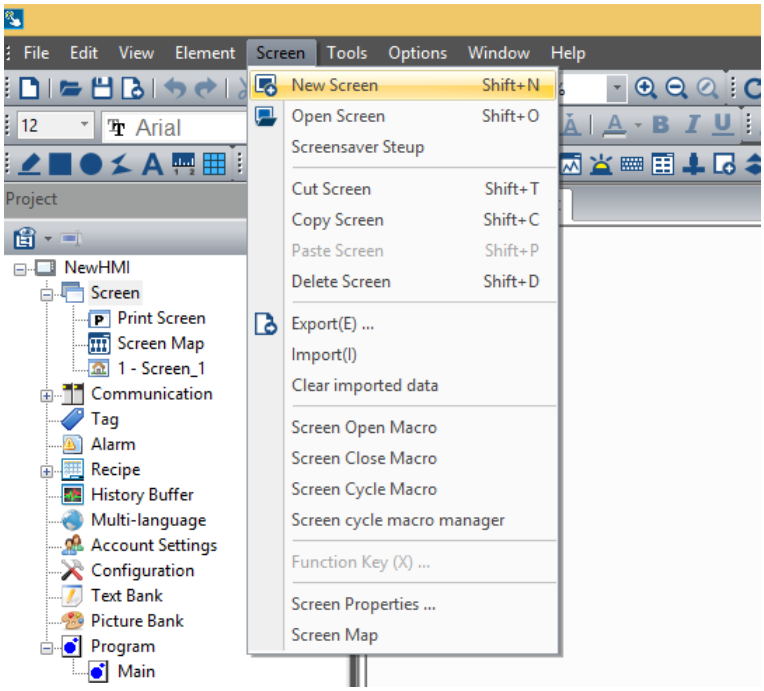




1.1.5.2 Design a project

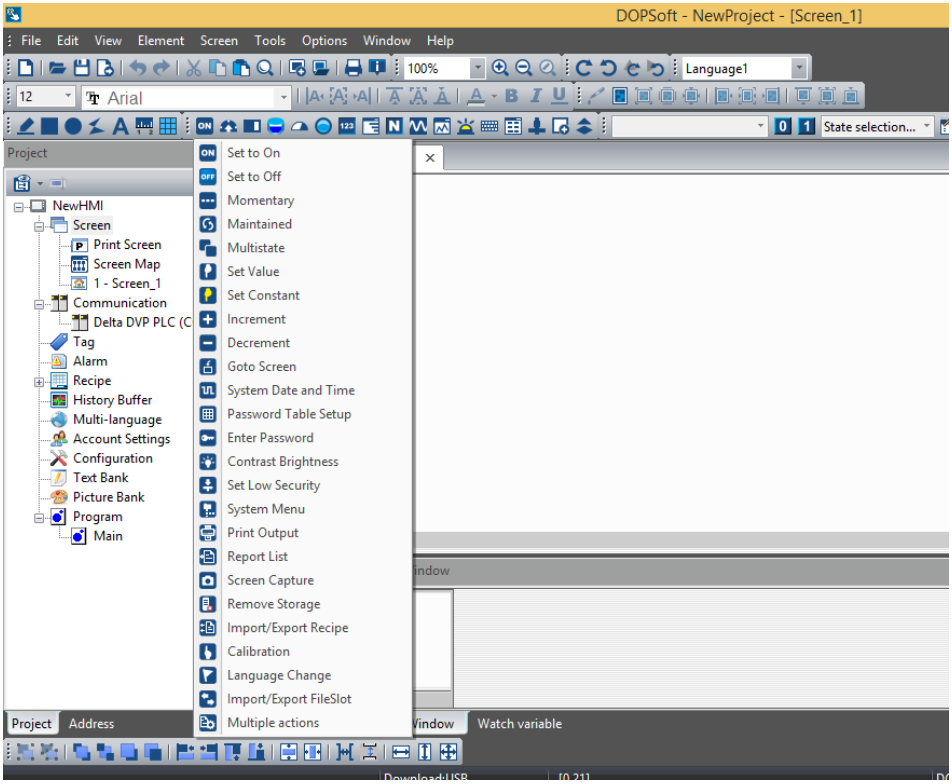
a. <u>Add pages</u>

To add pages, we click on « Screen-New Screen » or « Shift+N »

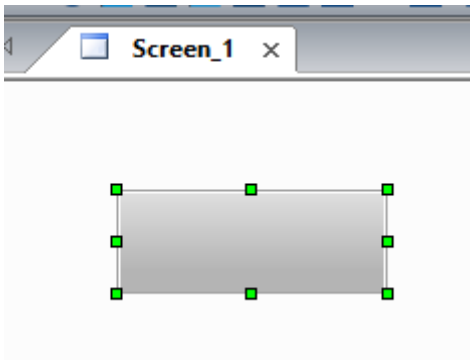


b. <u>Button (Write - Bit)</u>

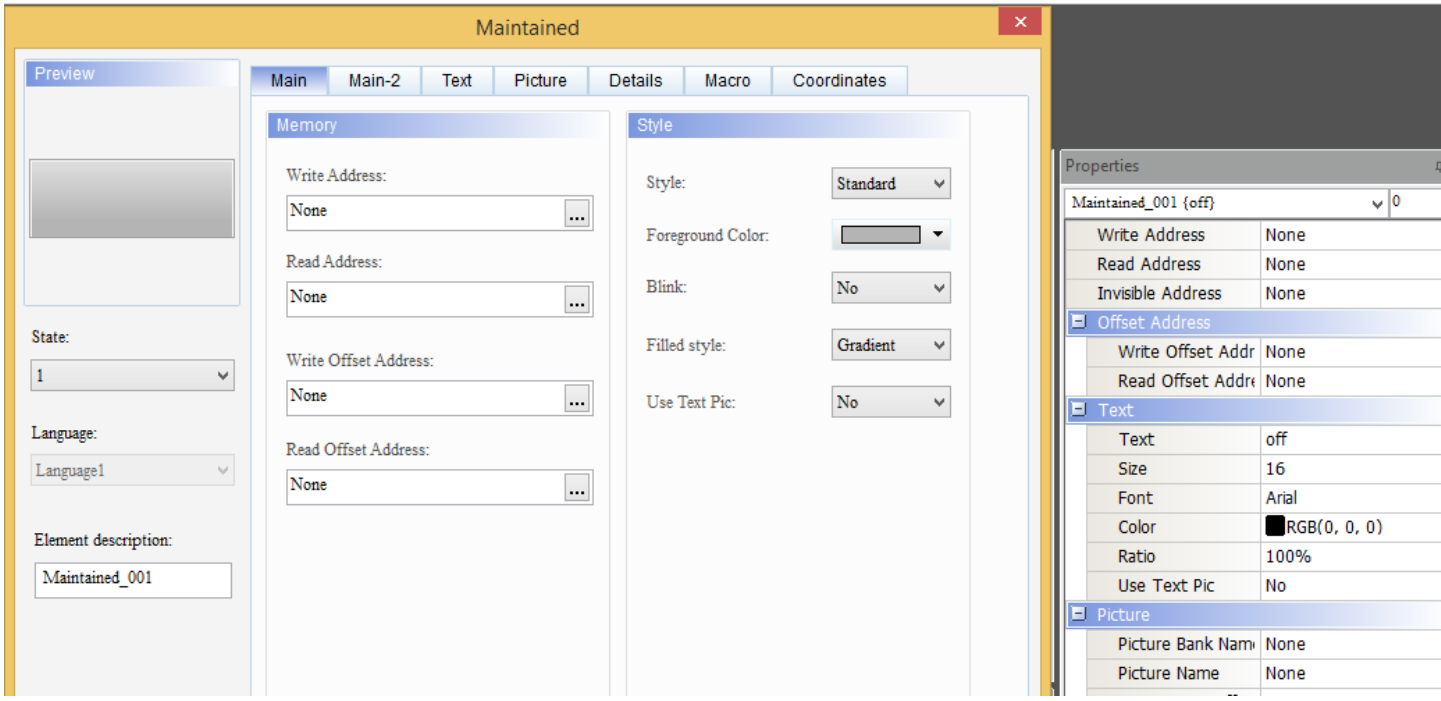
Set to On (ON Only)
Set to Off (OFF Only)
Maintained (OFF & ON)



Button

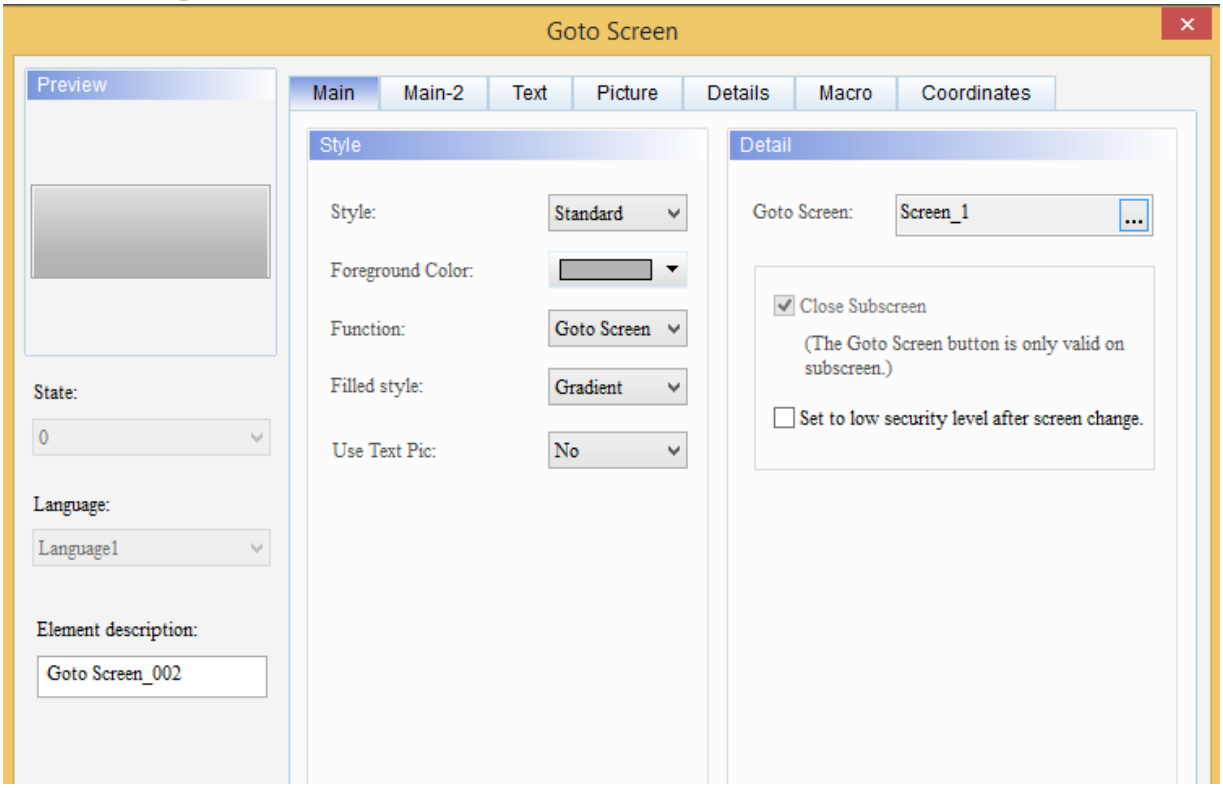


- We press the button to display the properties
- We enter the address of bit device for PLC in the «Proporties - Write address »

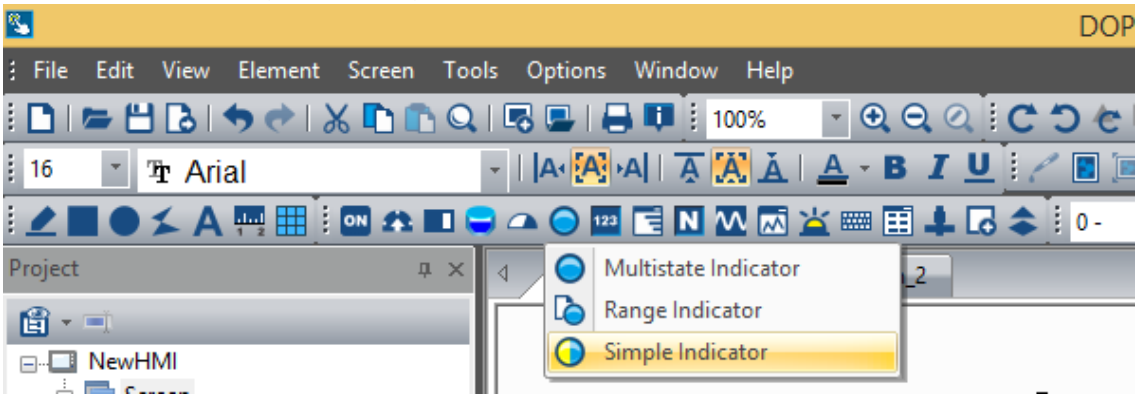


c. <u>Button - Goto Screen (Go to another page)</u>

We choose the name of the page we want to navigate to in the « Proporties - Goto screen »



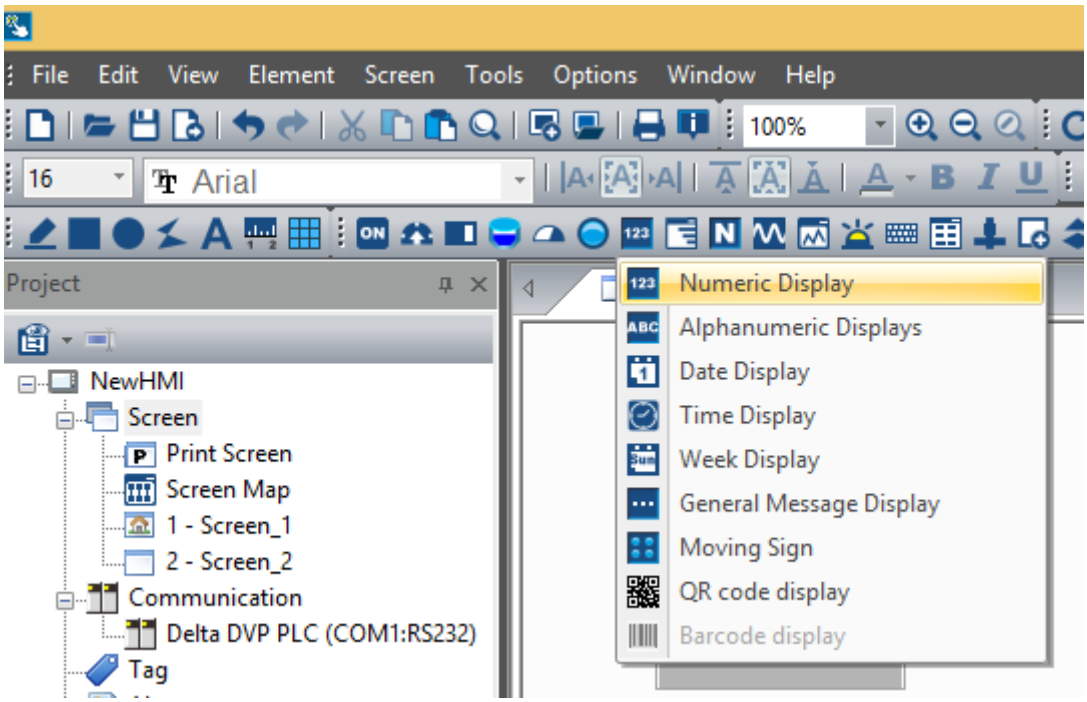
d. Indicator (Read-Bit)

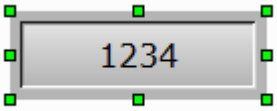


Simple Indicator

We enter the address of bit device for PLC in « Proporties - Read address »

e. Numeric Display (Read-Word)





Numeric Display

We enter the address of Word device for PLC in the « Proporties - Read address »

1.2 DELTA PLC (DVP20SX211R)

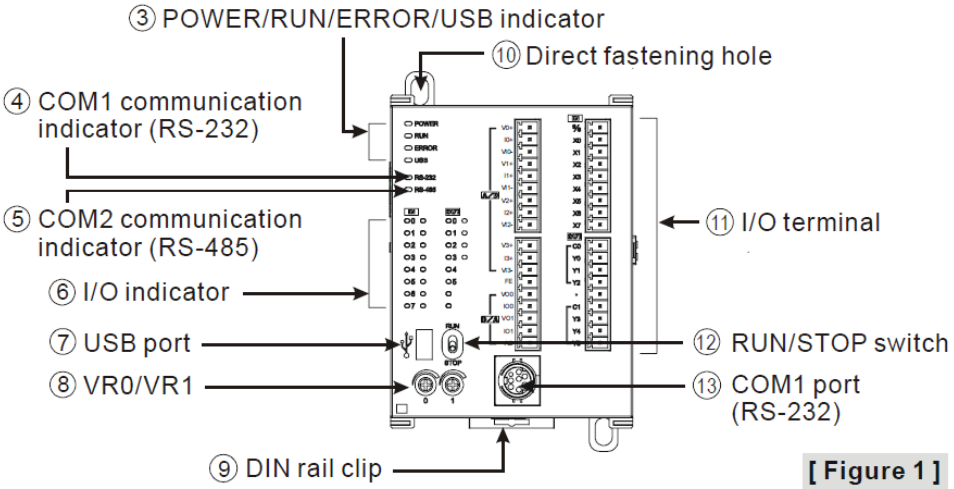
DELTA PLC - DVP20SX211R

1.2.1 Specifications

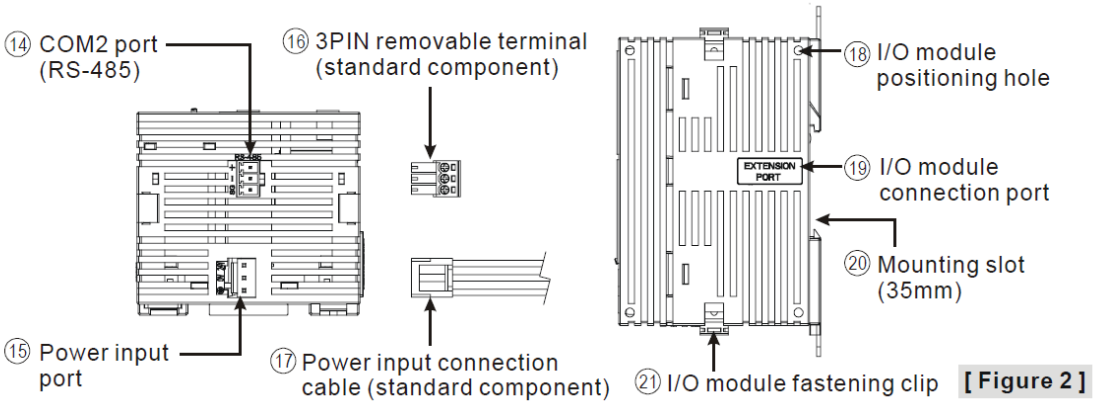
_ Program capacity: 16k steps/Data register: 10k words
_ Higher execution speed compared to the competition: LD: 0.35μs, MOV: 3.4μs
_ Built-in mini USB, RS-232 and RS-485 ports (Master/Slave) Supports standard MODBUS ASCII/RTU protocol and PLC Link function
_ Supports real time clocl for version 2.0 and above (no battery required) It operates for
at least one week after power off.
_Built-in 4 analog inputs / 2 analog outputs / 8 Digital Inputs & 6 Digital Outputs (Relay)
_ Supports DVP-S series left-side and right-side modules
_Power supply voltage : 24V DC

Built-in Analog I/O			
Analog Input		**Analog Output**	
Channels	4	**Channels**	2
Resolution	12-bit	**Resolution**	12-bit
Spec.	-20~20 mA or -10~10 V or 4~20 mA	**Spec.**	0~20 mA or -10 V~10 V or 4~20 mA

1.2.2 Product Profile



[Figure 1]



[Figure 2]

1.2.3 Point Specifications

1.2.3.1 Input point Specifications

Items \ Spec.		Input Point		
		24VDC (-15% ~ 20%) single common port input		
Input No.		X0, X2	X1, X3	X4 ~ X7
Input type		DC (SINK or SOURCE)		
Input Current (± 10%)		24VDC, 5mA		
Input impedance		4.7K Ohm		
Action level	Off→On	> 15VDC		
	On→Off	< 5VDC		
Response time	Off→On	< 2.5μs	< 10μs	< 20us
	On→Off	< 5μs	< 20μs	< 50us
Filter time		Adjustable within 0 ~ 20ms by D1020 (Default: 10ms)		

1.2.3.2 Output point Specifications

Items \ Spec.		Output Point
		Relay
Output No.		Y0 ~ Y5
Max. frequency		1Hz
Working voltage		250VAC, < 30VDC
Max. load	Resistive	1.5A/1 point (5A/COM)
	Inductive	#2
	Lamp	20WDC/100WAC
Response time	Off→On	Approx. 10 ms
	On→Off	

1.2.3.3 Analog input & Analog output Specifications

Items	Analog Input (A/D)			Analog Output (D/A)		
	Voltage	Current		Voltage	Current	
Analog I/O range	±10V	±20mA	4 ~ 20mA#1	±10V	0 ~ 20mA	4 ~ 20mA#1
Digital conversion range	±2,000	±2,000	0 ~ +2,000	±2,000	0 ~ +4,000	0 ~ +4,000
Resolution #2	12-bit					

1.2.3.4 Point Wiring

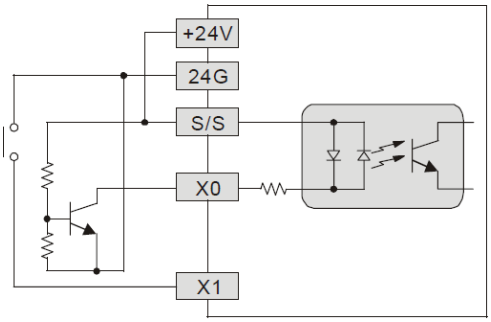
V0+	S/S
I0+	X0
VI0-	X1
V1+	X2
I1+	X3
VI1-	X4
V2+	X5
I2+	X6
VI2-	X7

V3+	C0
I3+	Y0
VI3-	Y1
FE	Y2
VO0	●
IO0	C1
VO1	Y3
IO1	Y4
AG	Y5

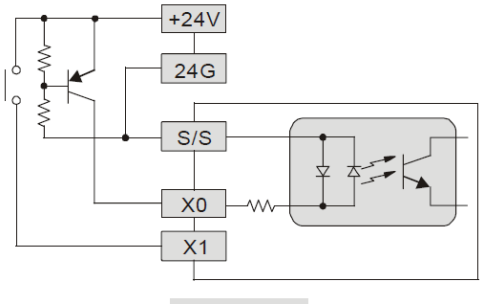
1.2.3.5 Input Point Wiring

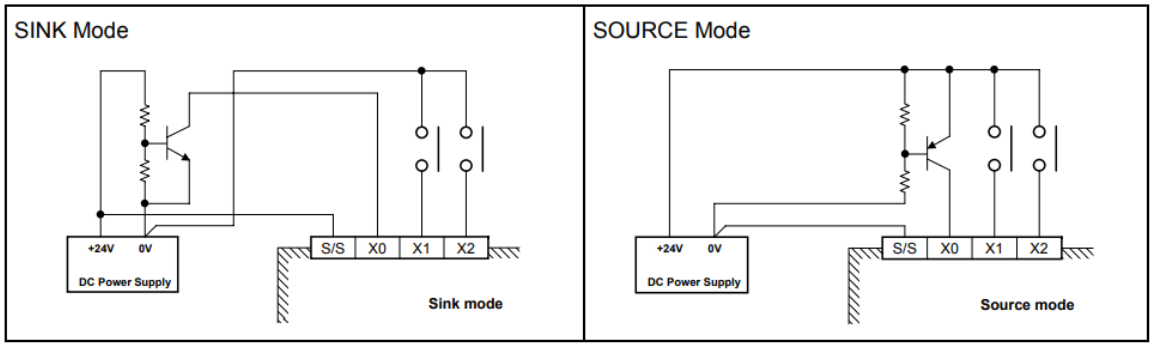
There are 2 types of DC inputs, SINK and SOURCE. (See the example below. For detailed point configuration, please refer to the specification of each model.)

• DC Signal IN – SINK mode
Input point loop equivalent circuit



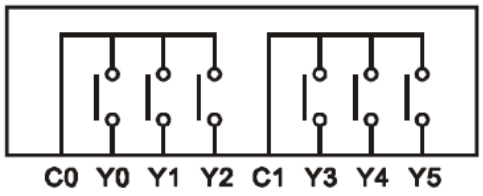
• DC Signal IN – SOURCE mode
Input point loop equivalent circuit



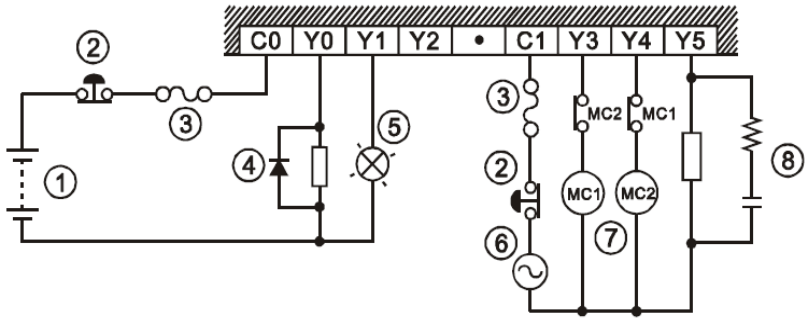


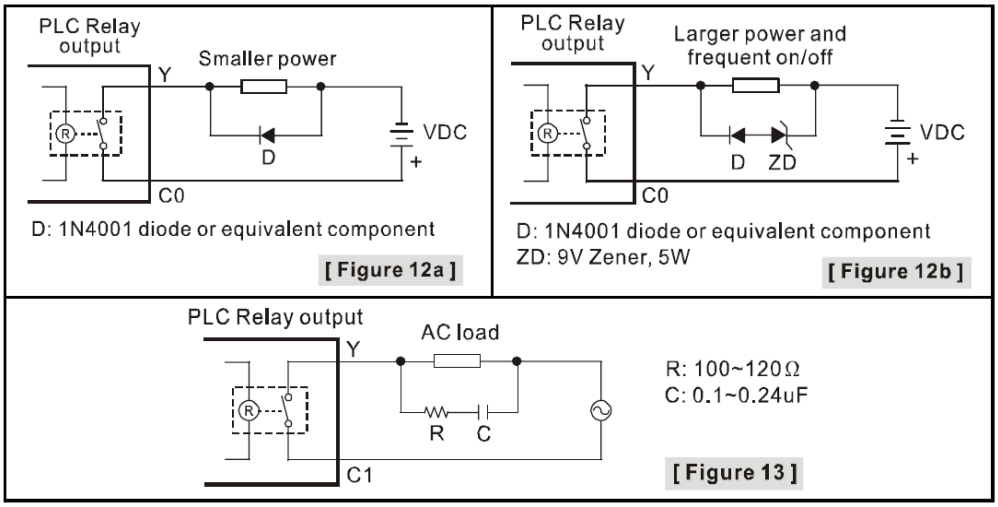
1.2.4 Output Point Wiring

Output terminals, Y0, Y1, and Y2, of relay models use C0 common port; Y3, Y4, and Y5 use C1 common port; as shown in the Figure . When output points are enabled, their corresponding indicators on the front panel will be on.



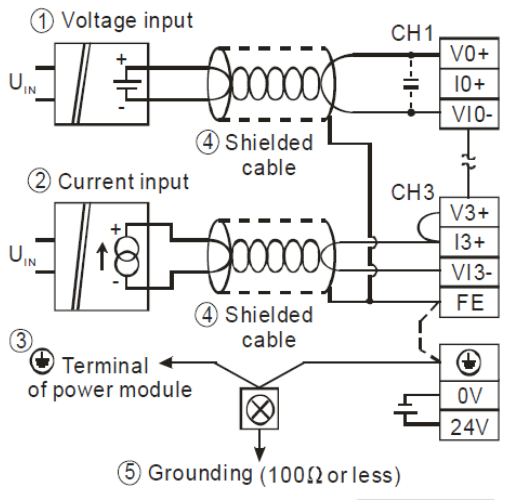
Relay (R) output circuit wiring



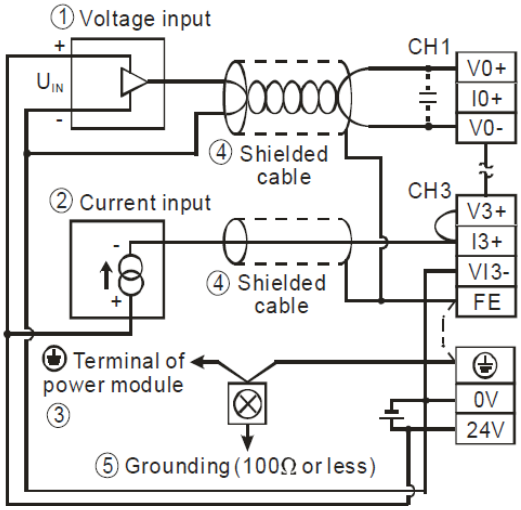


1.2.5 Analog input A/D & Analog output D/A External Wiring

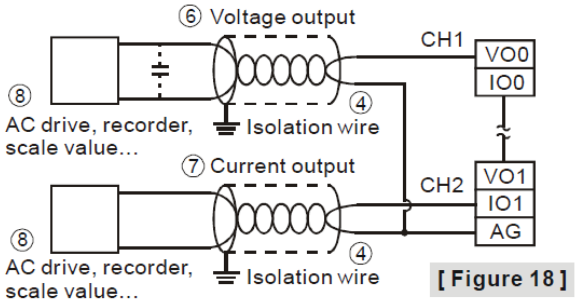
- A/D: Active



- A/D: Passive



- D/A



[Figure 18]

1.2.6 DVP20SX2 Memory Map

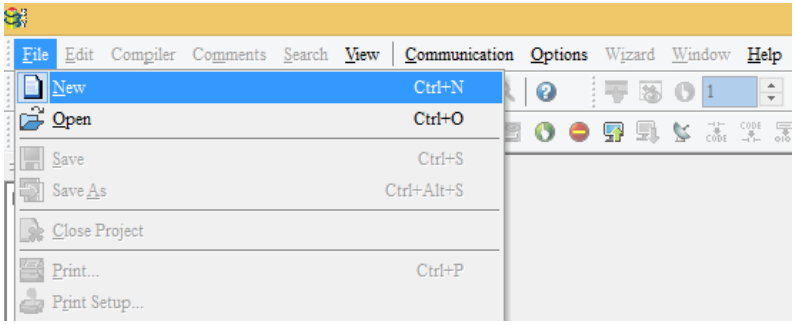
Specifications					
Control Method				Stored program, cyclic scan system	
I/O Processing Method				Batch processing method (when END instruction is executed)	
Execution Speed				LD instructions – 0.54μs, MOV instructions – 3.4μs	
Program language				Instruction List + Ladder + SFC	
Program Capacity				15872 steps	
Bit Contacts	X	External inputs		X0~X377, octal number system, 256 points max.	Total 480+32 I/O(*4)
	Y	External outputs		Y0~Y377, octal number system, 256 points max.	
	M	Auxiliary relay	General	M0~M511, 512 points, (*1) M768~M999, 232 points, (*1) M2000~M2047, 48 points, (*1)	Total 4096 points
			Latched	M512~M767, 256 points, (*2) M2048~M4095, 2048 points, (*2)	
			Special	M1000~M1999, 1000 points, some are latched	
	T	Timer	100ms (M1028=ON, T64~T126: 10ms)	T0~T126, 127 points, (*1) T128~T183, 56 points, (*1)	Total 256 points
				T184~T199 for Subroutines, 16 points (*1)	
				T250~T255(accumulative), 6 points (*1)	
			10ms (M1038=ON, T200~T245: 1ms)	T200~T239, 40 points, (*1)	
				T240~T245(accumulative), 6 points, (*1)	
			1ms	T127, 1 points, (*1) T246~T249(accumulative), 4 points, (*1)	
	C	Counter	16-bit count up	C0~C111, 112 points, (*1) C128~C199, 72 points, (*1)	Total 233 points
				C112~C127, 16 points, (*2)	
			32-bit count up/down	C200~C223, 24 points, (*1)	
				C224~C232, 9 points, (*2)	
			32bit high-speed count up/down, Soft-ware	C235~C242, 1 phase 1 input, 8 points, (*2)	Total 22 points
				C233~C234, 2 phase 2 input, 2 points, (*2)	
			32bit high-speed count up/down, Hard-ware	C243~C244, 1 phase 1 input, 2 points, (*2)	
				C245~C250, 1 phase 2 input, 6 points, (*2)	
				C251~C254 2 phase 2 input, 4 points, (*2)	
	S	Step point	Initial step point	S0~S9, 10 points, (*2)	Total 1024 points
			Zero point return	S10~S19, 10 points (use with IST instruction), (*2)	
			Latched	S20~S127, 108 points, (*2)	
			General	S128~S911, 784 points, (*1)	
			Alarm	S912~S1023, 112 points, (*2)	

Specifications					
Word Register	T	Current value		T0~T255, 256 words	
	C	Current value		C0~C199, 16-bit counter, 200 words	
				C200~C254, 32-bit counter, 55 words	
	D	Data register	General	D0~D407, 408 words, (*1) D600~D999, 400 words, (*1) D3920~D9799, 5880 words, (*1)	Total 10000 points
			Latched	D408~D599, 192 words, (*2) D2000~D3919, 1920 words, (*2)	
			Special	D1000~D1999, 1000 words, some are latched	
			Righ-side special module	D9900~D9999, 100 words (*1) (*6)	
			Left-side special module	D9800~D9899, 100 words (*1) (*7)	
			Index	E0~E7, F0~F7, 16 words, (*1)	
Pointer	N	Master control loop		N0~N7, 8 points	
	P	Pointer		P0~P255, 256 points	
	I	Interrupt Service	External interrupt	I000/I001(X0), I100/I101(X1), I200/I201(X2), I300/I301(X3), I400/I401(X4), I500/I501(X5), I600/I601(X6), I700/I701(X7), 8 points (01: rising-edge trigger ┘, 00: falling-edge trigger └)	
			Timer interrupt	I602~I699, I702~I799, 2 points (Timer resolution = 1ms) I805~I899, 1 point (Timer resolution = 0.1ms) (Supported by V2.00 and above)	
			High-speed counter interrupt	I010, I020, I030, I040, I050, I060, I070, I080, 8 points	
			Communication interrupt	I140(COM1), I150(COM2), I160(COM3), 3 points, (*3)	
Constant	K	Decimal		K-32,768 ~ K32,767 (16-bit operation), K-2,147,483,648 ~ K2,147,483,647 (32-bit operation)	
	H	Hexadecimal		H0000 ~ HFFFF (16-bit operation), H00000000 ~HFFFFFFFF (32-bit operation)	
Serial Ports			SA2	COM1: built-in RS-232 ((Master/Slave) COM2: built-in RS-485 (Master/Slave) COM3: built-in RS-485 (Master/Slave) COM1 is typically the programming port.	
			SX2	COM1: built-in RS-232 ((Master/Slave) COM2: built-in RS-485 (Master/Slave) COM3: built-in USB (Slave) COM1 is typically the programming port.	
Real Time Clock				Year, Month, Day, Week, Hours, Minutes, Seconds	
Special I/O Modules				Right side: Up to 8 I/O modules can be connected Left side: Up to 8 high-speed I/O module can be connected	
File Register (*5)				K0~K4999, 5000 points (*2)	

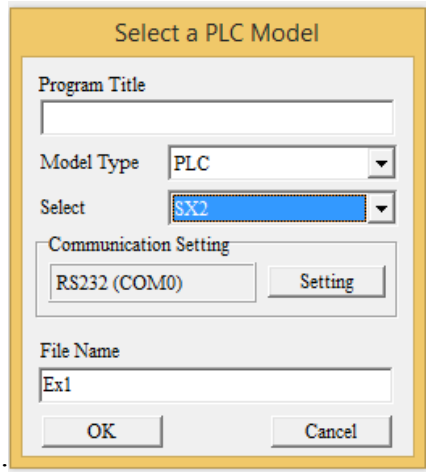
1.2.7 Software “WPL Soft” for PLC programming

1.2.7.1 Create a Project

- We click on «File-New »

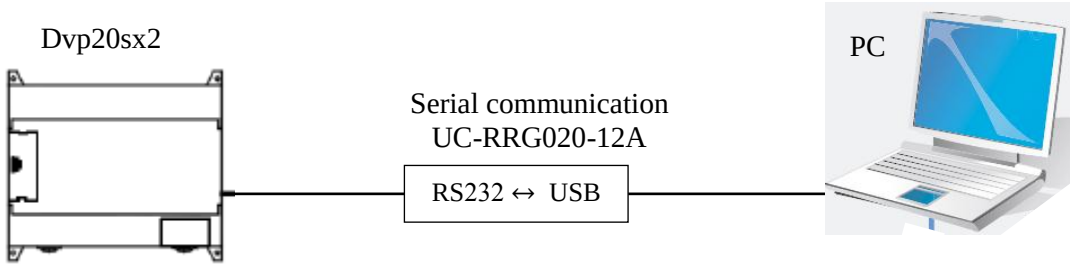


- We choose the PLC product «SX2 »
- We put a name in the «File Name»
- We click on «OK »

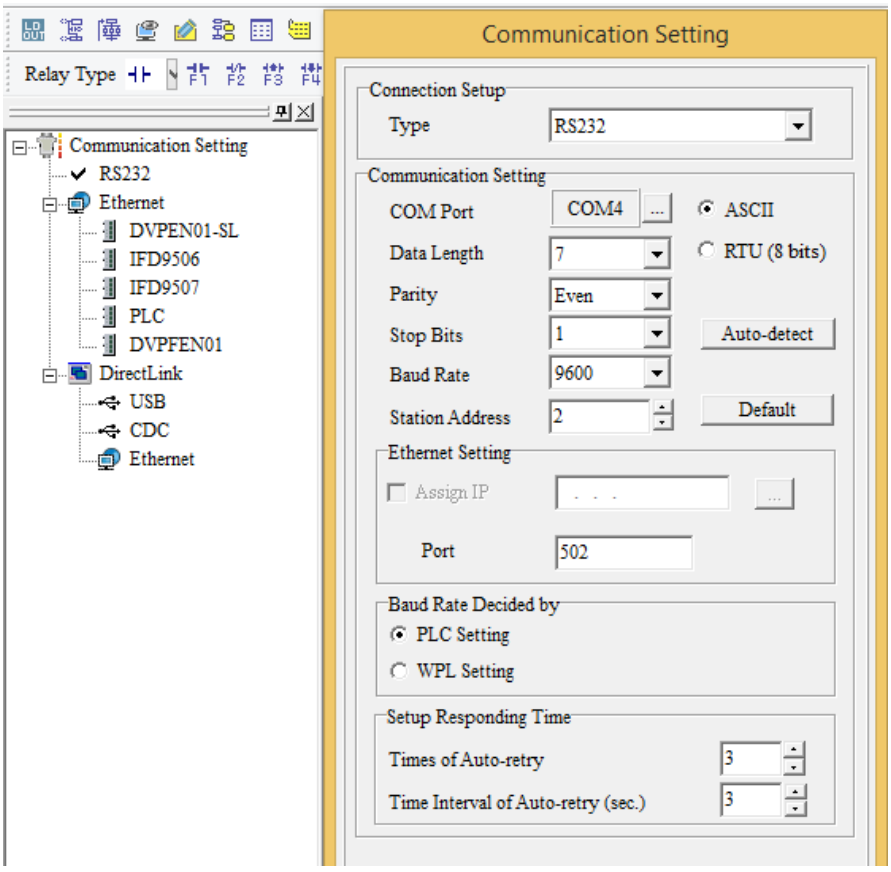


1.2.7.2 The necessary steps to download the program on the PLC

We Use Programming cable (UC-PRG020-12A) connecting a computer and a PLC.

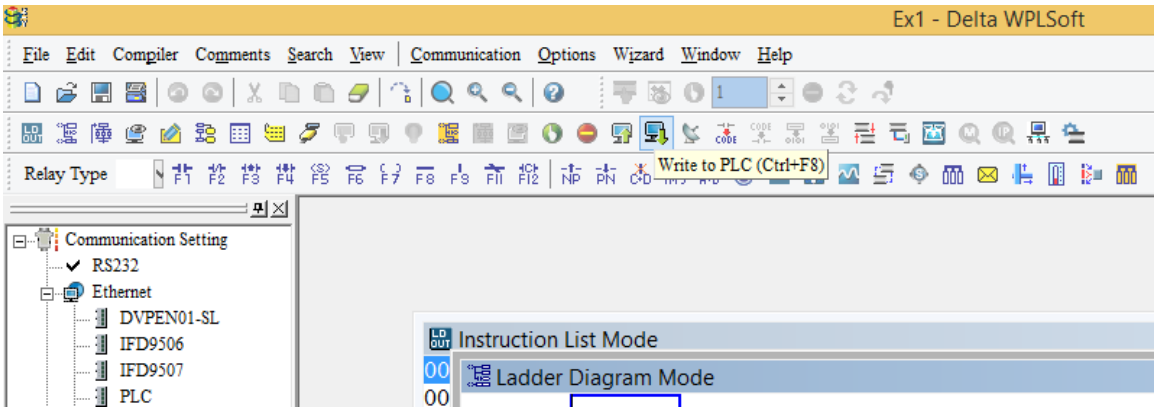


- We click on “Communication setting- RS232 “ to check the port (COM).
- we put The PLC address in Station address



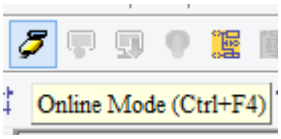
1.2.7.3 Downloading a PLC program

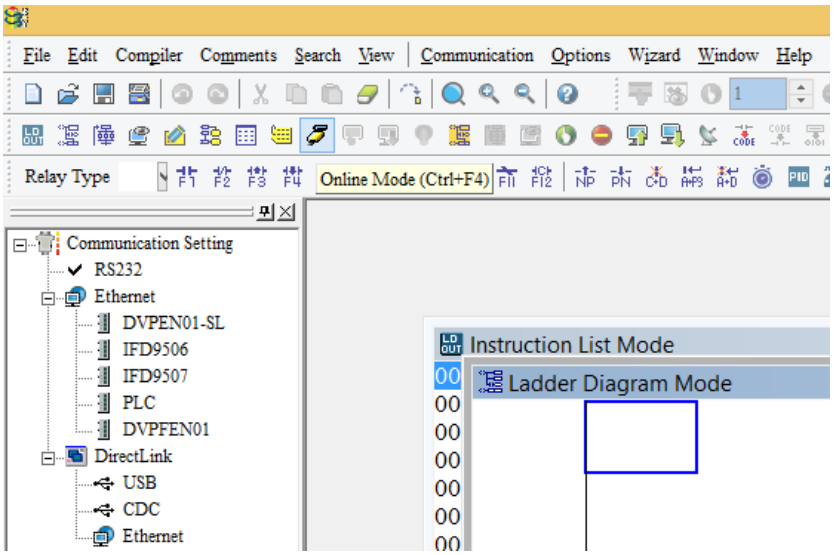
To download the program, we click on the following form :



1.2.7.4 Monitoring a Program

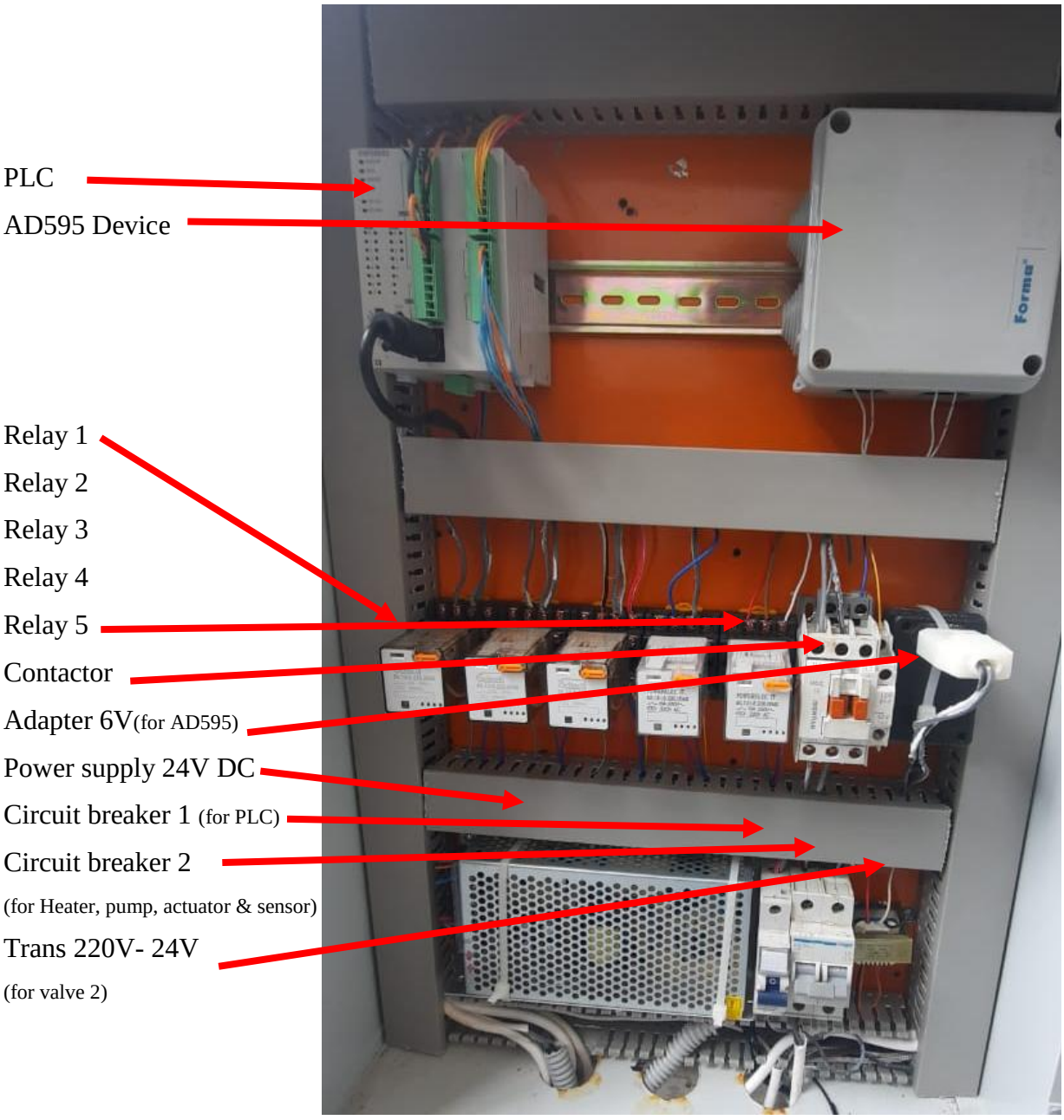
To monitor the program's work in the PLC, we click on the following form:




File Edit Compiler Comments Search View Communication Options Wizard Window Help
Relay Type
Online Mode (Ctrl+F4)
Communication Setting
RS232
Ethernet
DVPEN01-SL
IFD9506
IFD9507
PLC
DVPFEN01
DirectLink
USB
CDC
Ethernet
Instruction List Mode
Ladder Diagram Mode
00
00
00
00
00
00

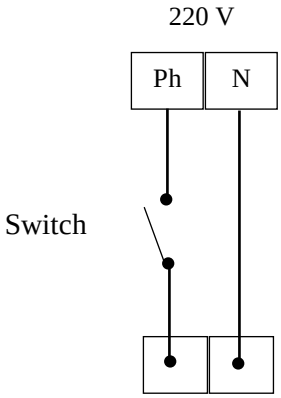
2 Connecting the sensors & actuators

2.1 Control Panel



2.2 Pump 1

Power circuit between the Switch & the Pump 1



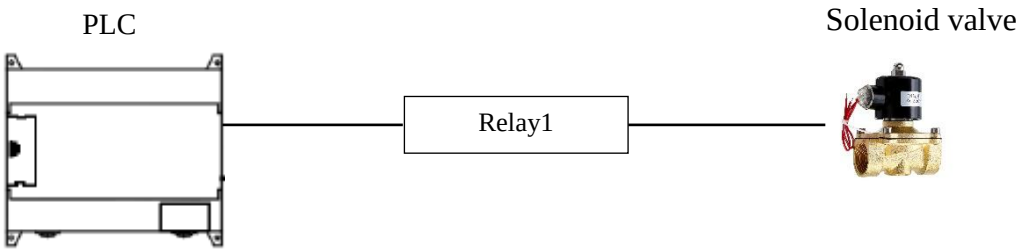
Pump 1

Switch of Pump 1

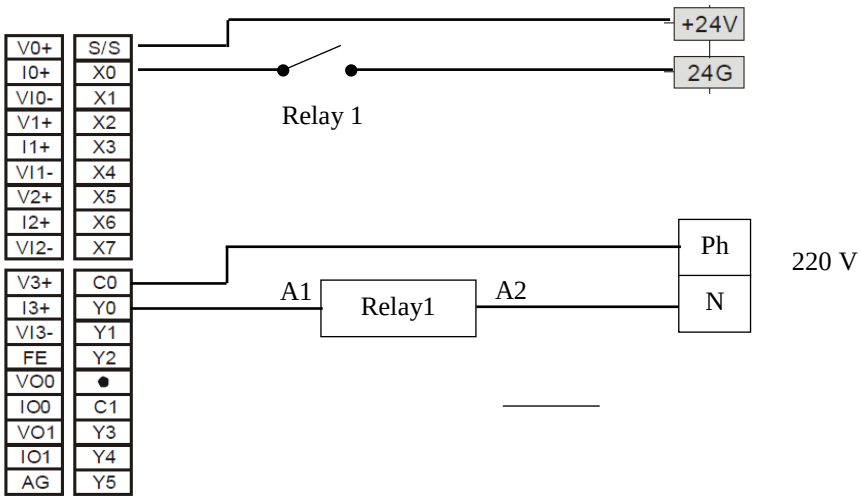
2.3 Solenoid valve

Voltage: AC220V
Fluid Temperature: 0~200℃

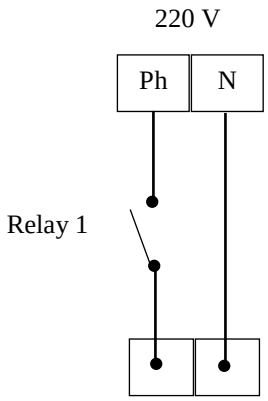
Connecting between the PLC & the Solenoid valve



Control circuit between the PLC & the relay 1



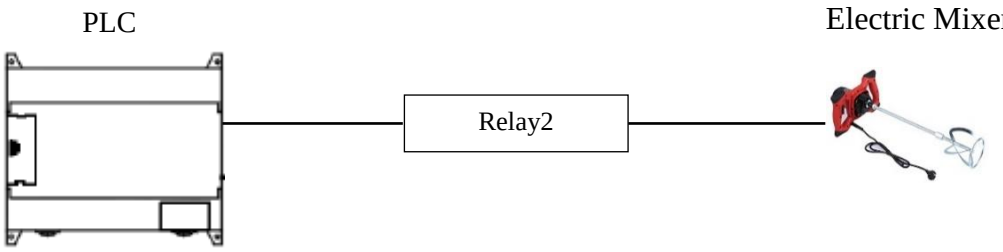
Power circuit between relay 1 & solenoid valve



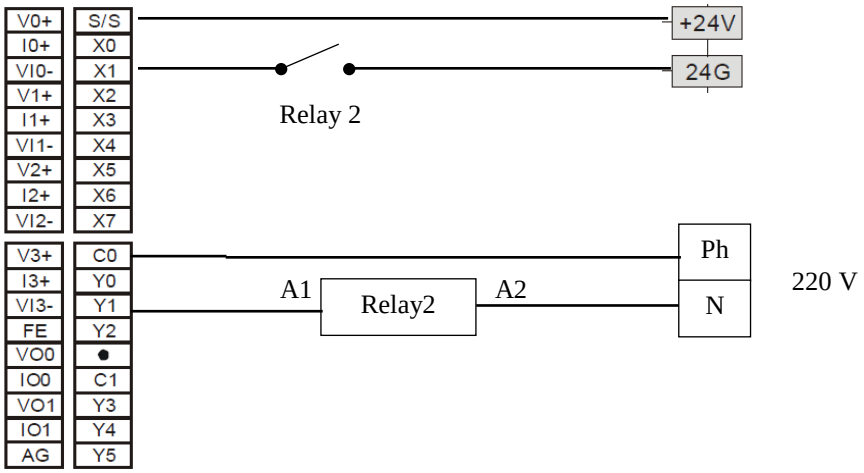
2.4 Electric Mixer

Voltage: AC220V

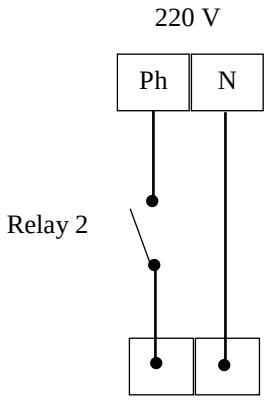
Connecting between the PLC & the electric Mixer



Control circuit between the PLC & the relay 2



Power circuit between relay 2 & Electric Mixer

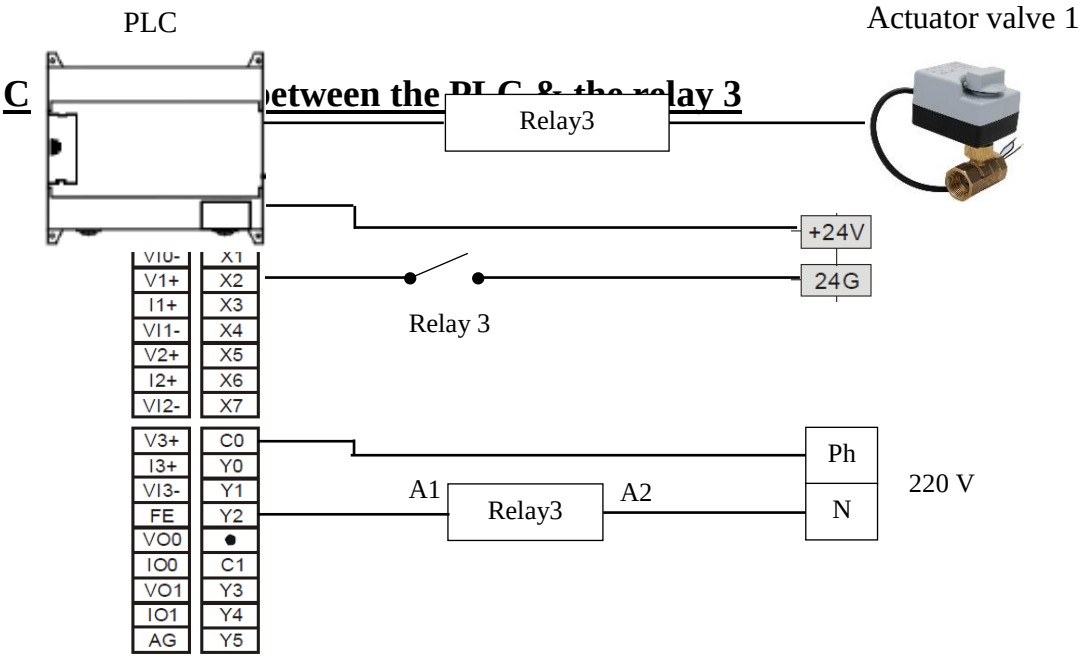


Electric Mixer

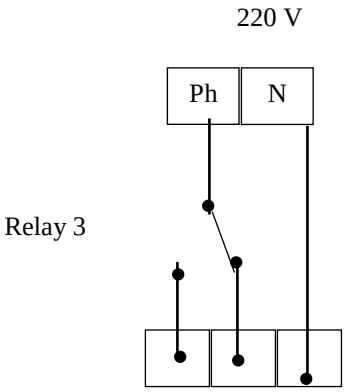
2.5 Electric Actuator Valve 1

Voltage: AC220V

Connection between the PLC & the Actuator Valve 1



Power circuit between relay 3 & Actuator valve 1

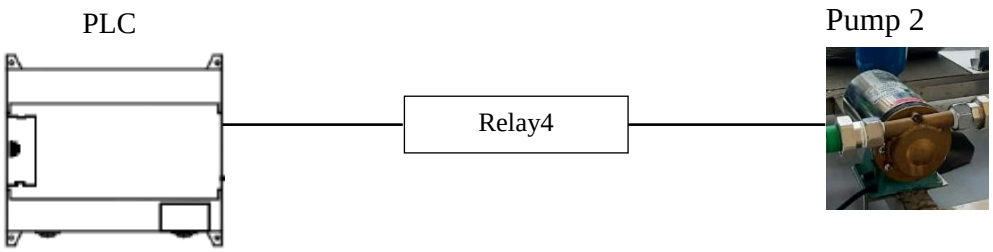


Actuator valve 1

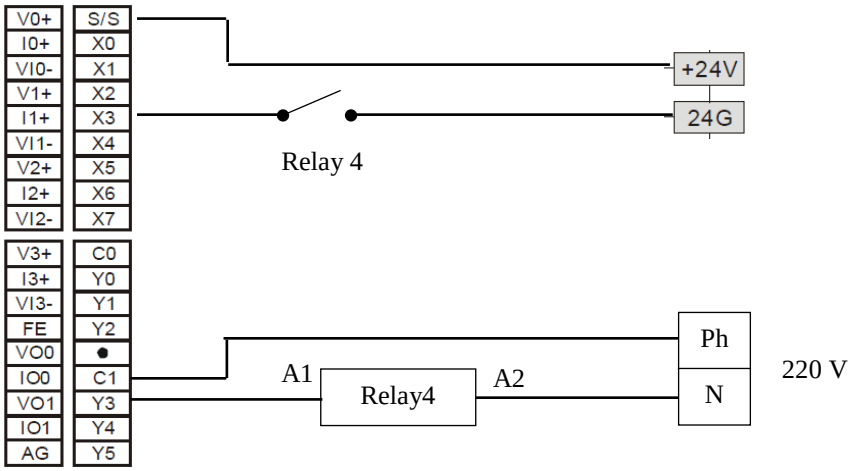
2.6 Pump 2

Voltage: AC220V

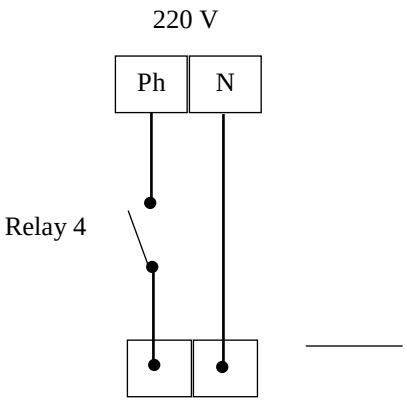
Connecting between the PLC & the Pump 2



Control circuit between the PLC & the relay 4



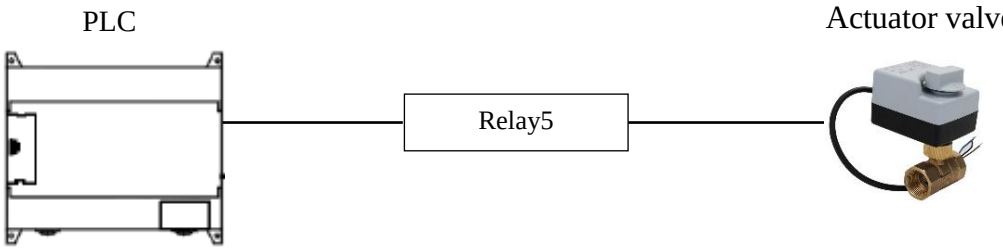
Power circuit between relay 4 & the Pump 2



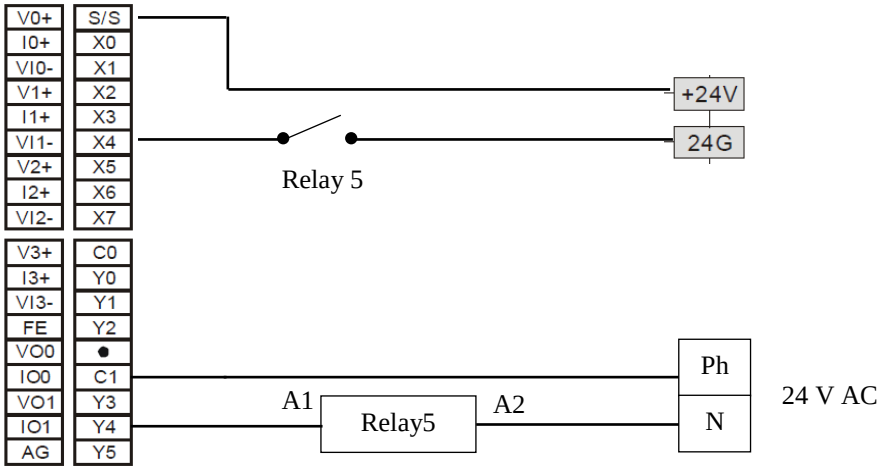
2.7 Electric Actuator Valve 2

Voltage: AC 24V

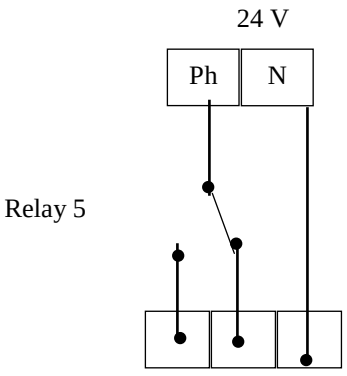
Connecting between the PLC & the Actuator Valve 2



Control circuit between the PLC & the relay 5



Power circuit between relay 5 & Actuator valve 2

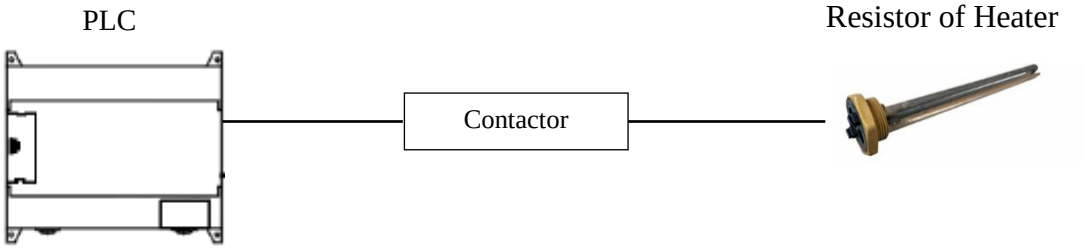


Actuator valve 2

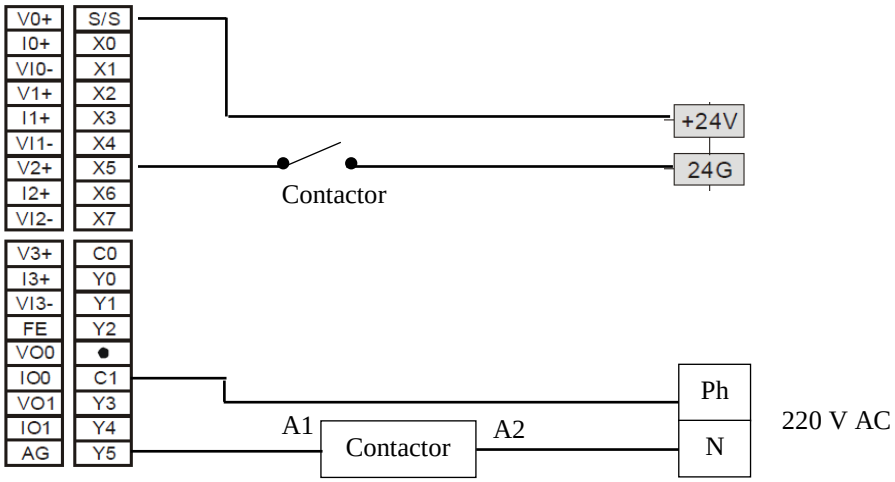
2.8 Resistor of Heater

Voltage: AC 220V

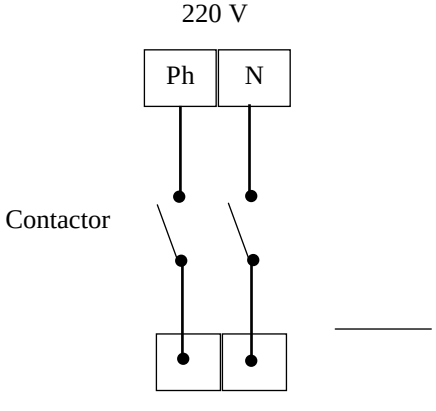
Connecting between the PLC & the Resistor of Heater



Control circuit between the PLC & the Contactor

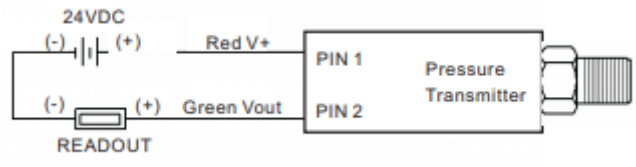


Power circuit between Contactor & the Resistor of heater

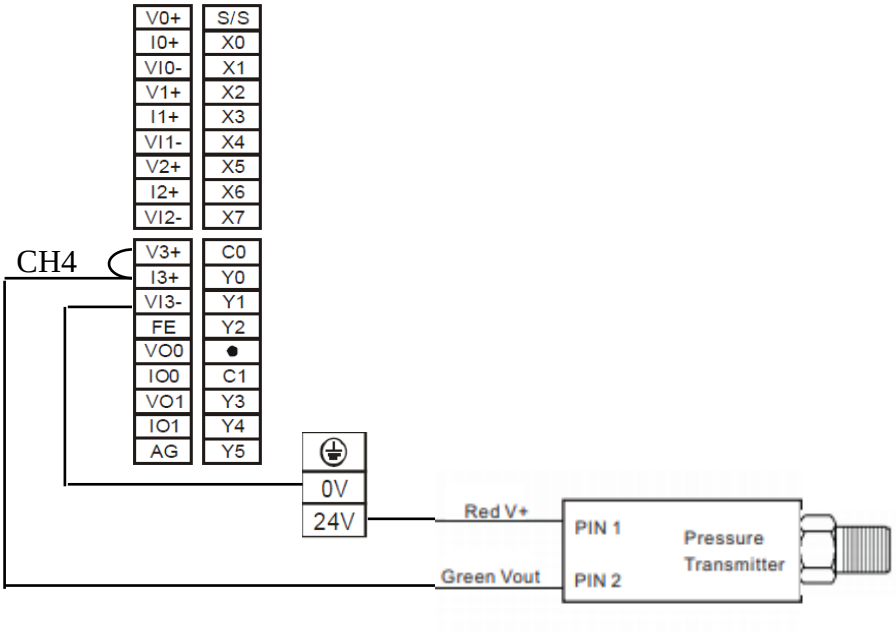


2.9 Pressure sensor of heater

MODEL : GPT220
Range : 0-16bar
Output : 4-20 mA
Power : 12- 36V
Temperature : 220^0 C

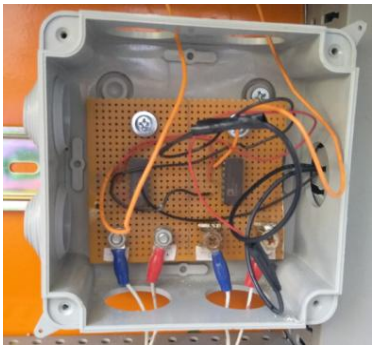


Connecting between the PLC & the Pressure sensor

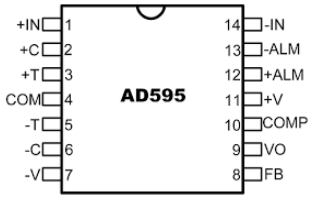


2.10 Temperature sensor of penicillin fermenter tank

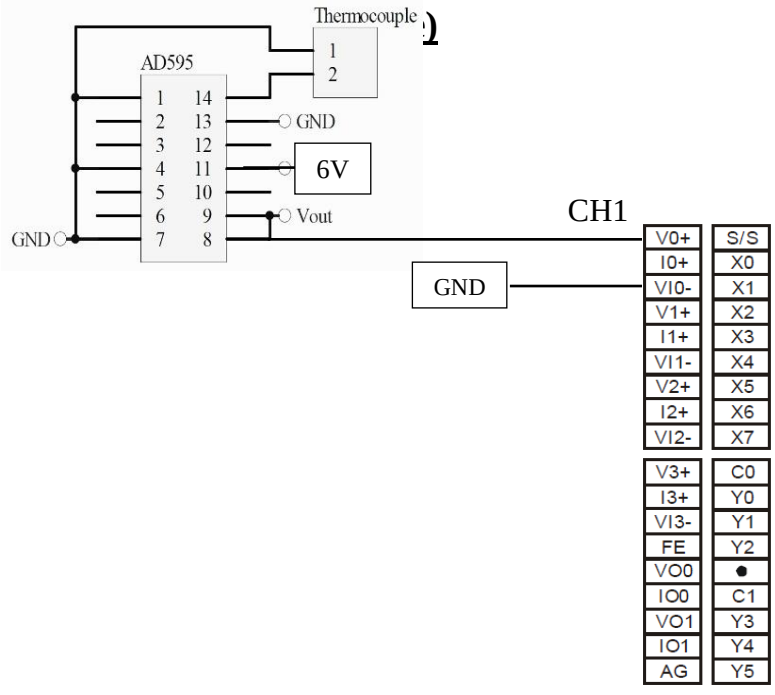
Temperature sensor (K-Thermocouple)



AD959 device



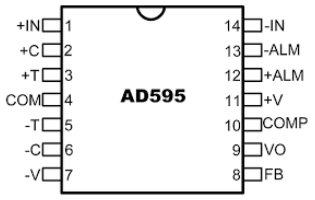
Connecting between the PLC, the AD959 device & the Temperature

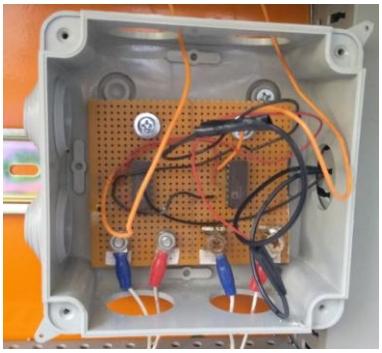


2.11 Temperature sensor of Heater tank

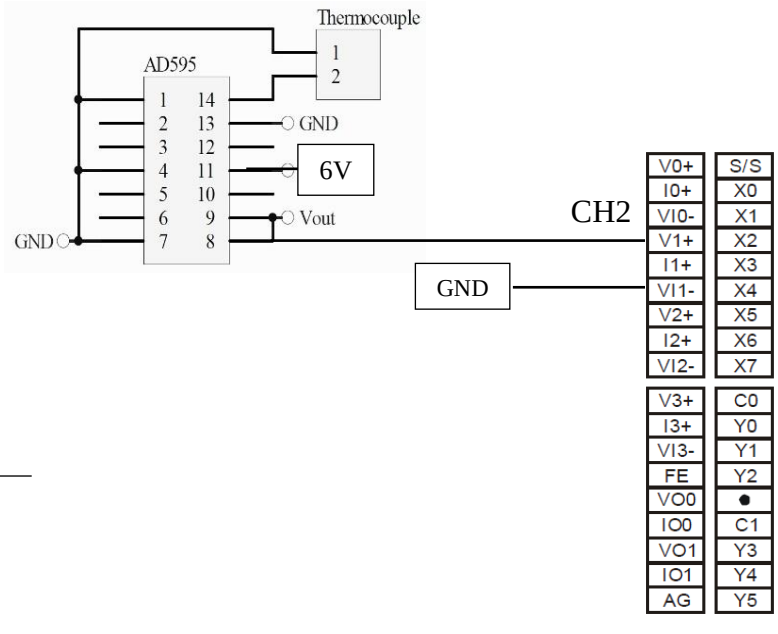
Temperature sensor (K-Thermocouple)

AD959 device





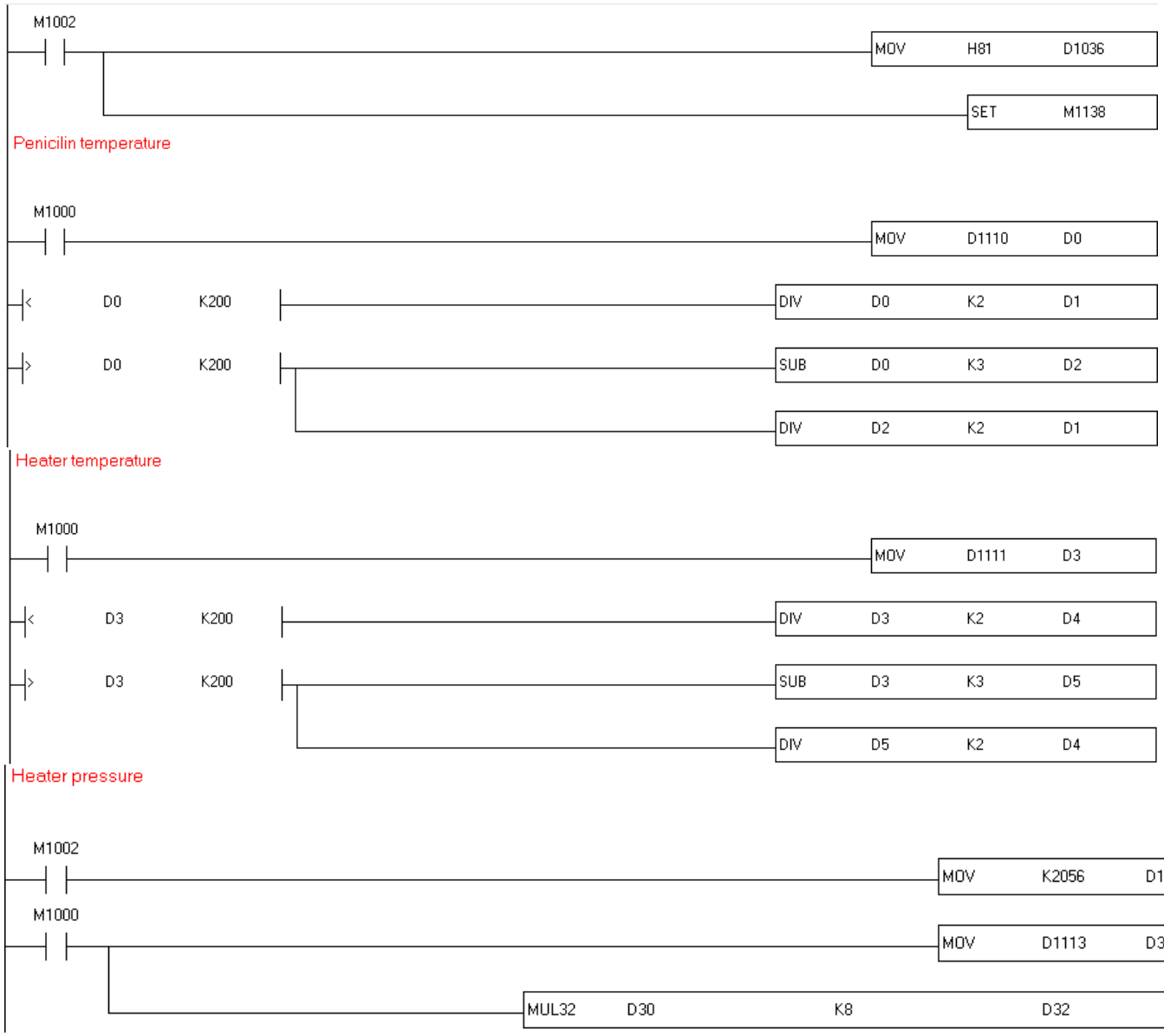
Connecting between the PLC, the AD959 device & the Temperature sensor (K-Thermocouple)

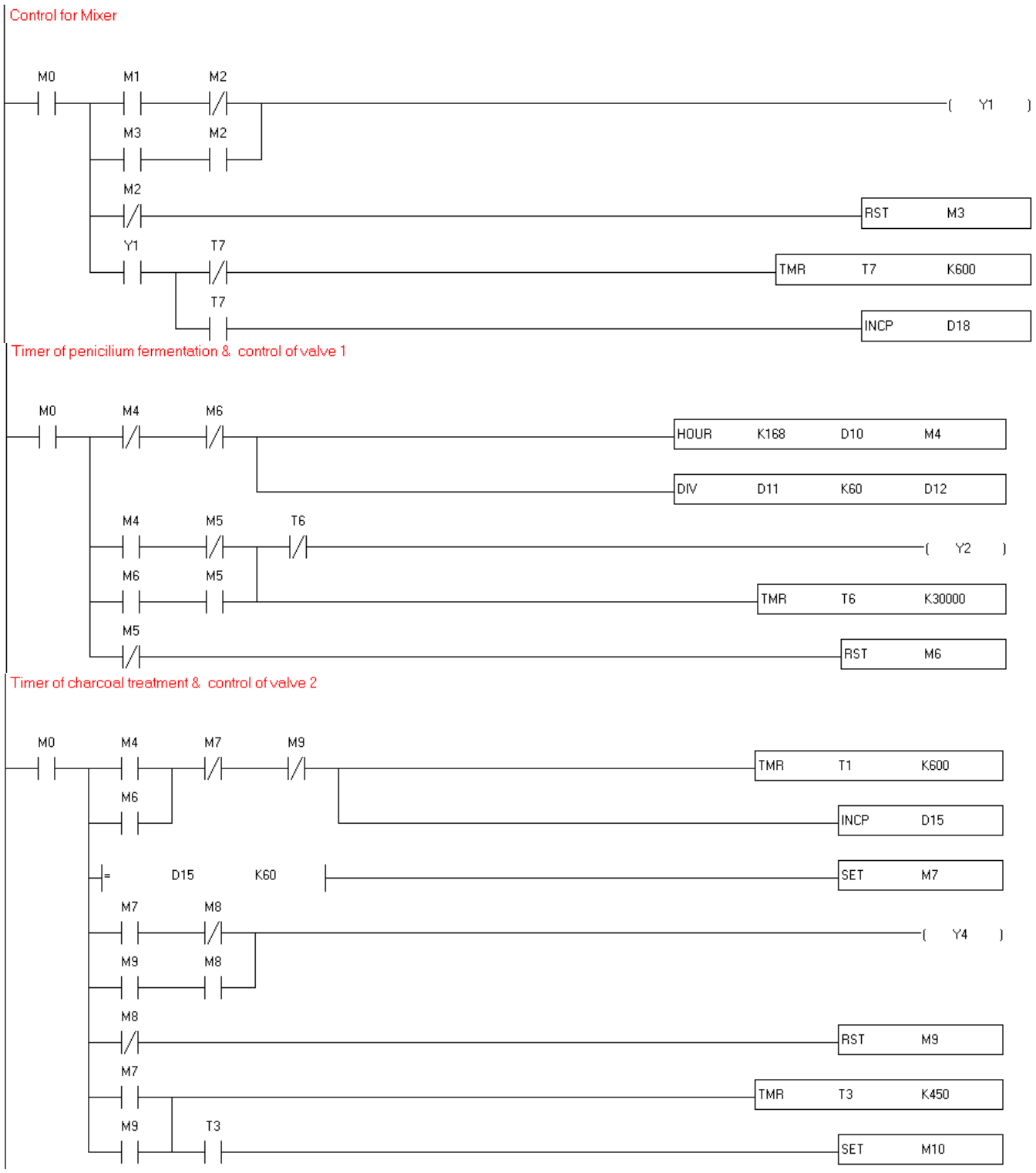


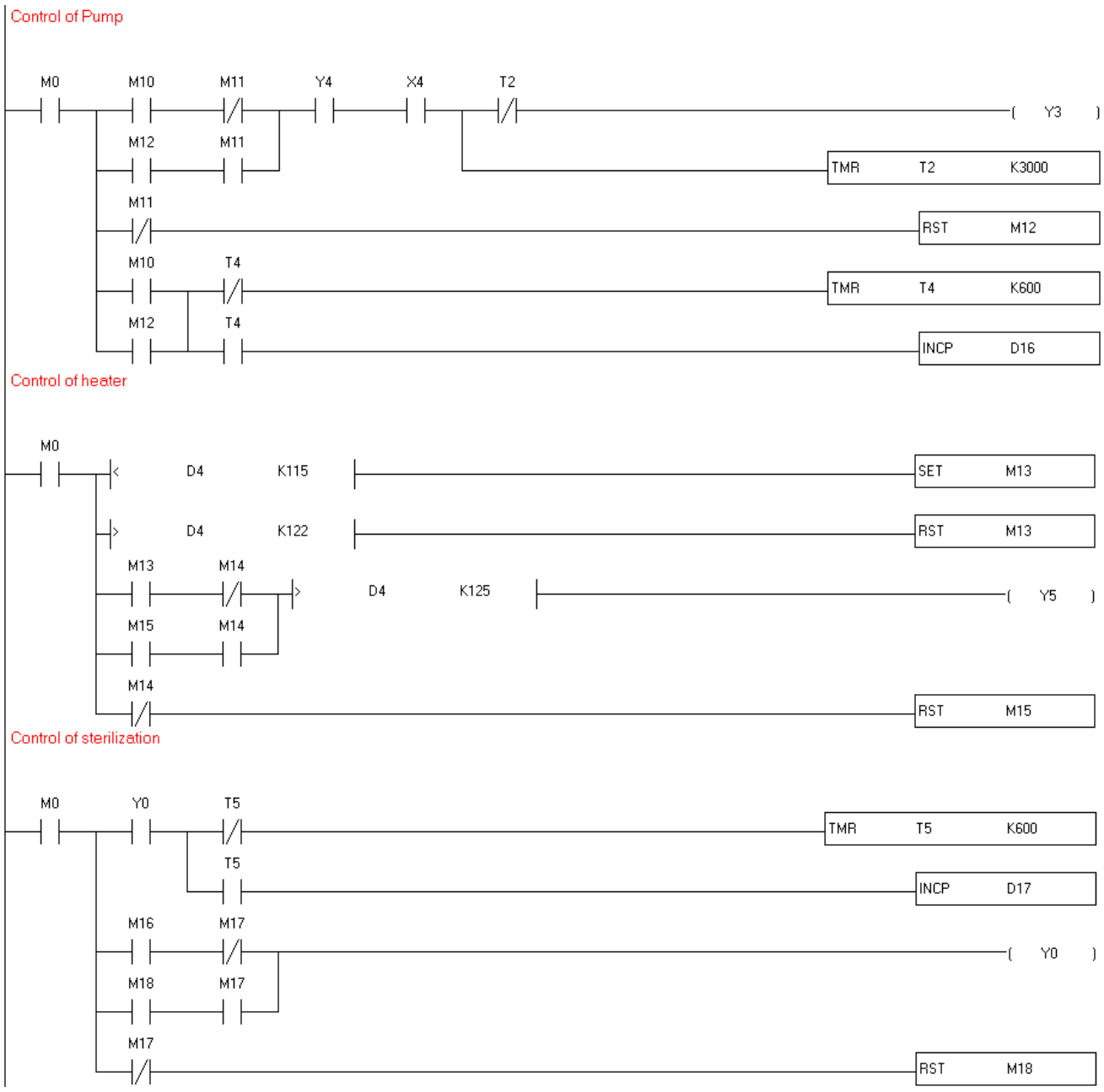
3 Control system for PLC & HMI

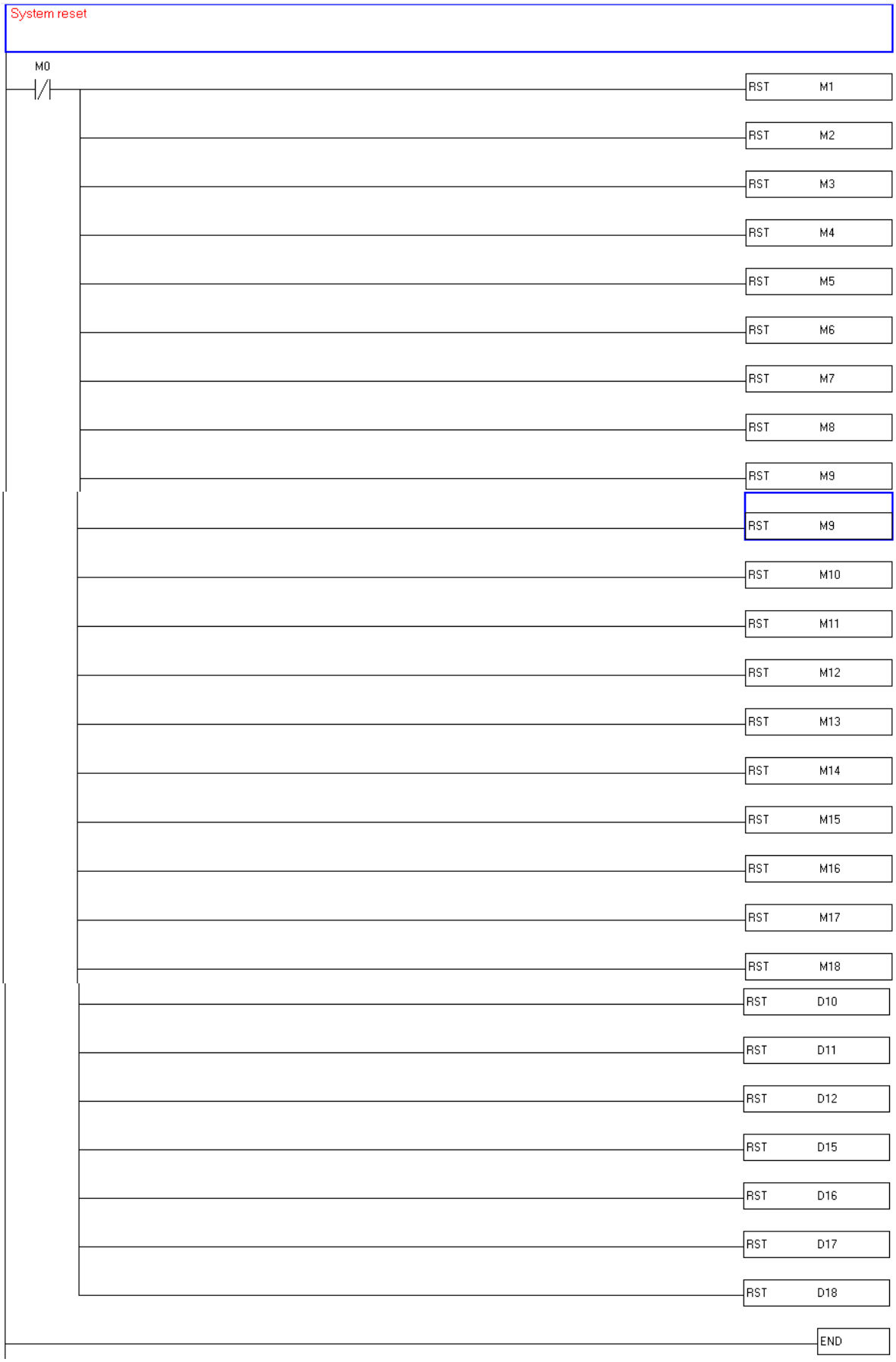
3.1 Programme of PLC

MEGBI-APP-Control System.dvp	Program code (please click and open in any editor, e.g. notepad++)




Control for Mixer
M0
M1
M2
Y1
M3
M2
M2
RST M3
Y1
T7
TMR T7 K600
T7
INCP D18
Timer of penicilium fermentation & control of valve 1
M0
M4
M6
HOUR K168 D10 M4
DIV D11 K60 D12
M4
M5
T6
Y2
M6
M5
TMR T6 K30000
M5
RST M6
Timer of charcoal treatment & control of valve 2
M0
M4
M7
M9
TMR T1 K600
M6
INCP D15
= D15 K60
SET M7
M7
M8
Y4
M9
M8
M8
RST M9
M7
TMR T3 K450
M9
T3
SET M10


Control of Pump
M0
M10
M11
Y4
X4
T2
Y3
M12
M11
TMR T2 K3000
M11
RST M12
M10
T4
TMR T4 K600
M12
T4
INCP D16
Control of heater
M0
D4 K115
SET M13
D4 K122
RST M13
M13
M14
D4 K125
Y5
M15
M14
M14
RST M15
Control of sterilization
M0
Y0
T5
TMR T5 K600
T5
INCP D17
M16
M17
Y0
M18
M17
M17
RST M18


System reset
M0
RST M1
RST M2
RST M3
RST M4
RST M5
RST M6
RST M7
RST M8
RST M9
RST M9
RST M10
RST M11
RST M12
RST M13
RST M14
RST M15
RST M16
RST M17
RST M18
RST D10
RST D11
RST D12
RST D15
RST D16
RST D17
RST D18
END

3.2 HMI Program

3.2.1 Auto mode

Press “Start”

- Start Timer 1 of tank 1, Mixer ON
- Delay 168 hours (7 days)
- If Timer 1= 168 hours, Open Valve 1
- Start Timer 2 of tank 2
- If Timer 2 = 1 hour, Open Valve 2
- Pump 2 ON for 5 min after Valve 2 is open

3.2.2 Manuel mode (interactive)

Press “Start”

Fermentation pen cilium :

a) Mixer :
- Press “Manual”
- for OFF Press “Manual OFF”
- for ON press “Manal ON”

b) Valve :
- Press “Manual”
- for Open Press “Manual Open”
- for Close press “Manal Close ”

Charcoal treatment :

a) Valve :
- Press “Manual”
- for Open Press “Manual Open”
- for Close press “Manal Close ”

b) Pump : (if valve 2 Close, Pump not working)
- Press “Manual”
- for OFF Press “Manual OFF”
- for ON press “Manal ON”

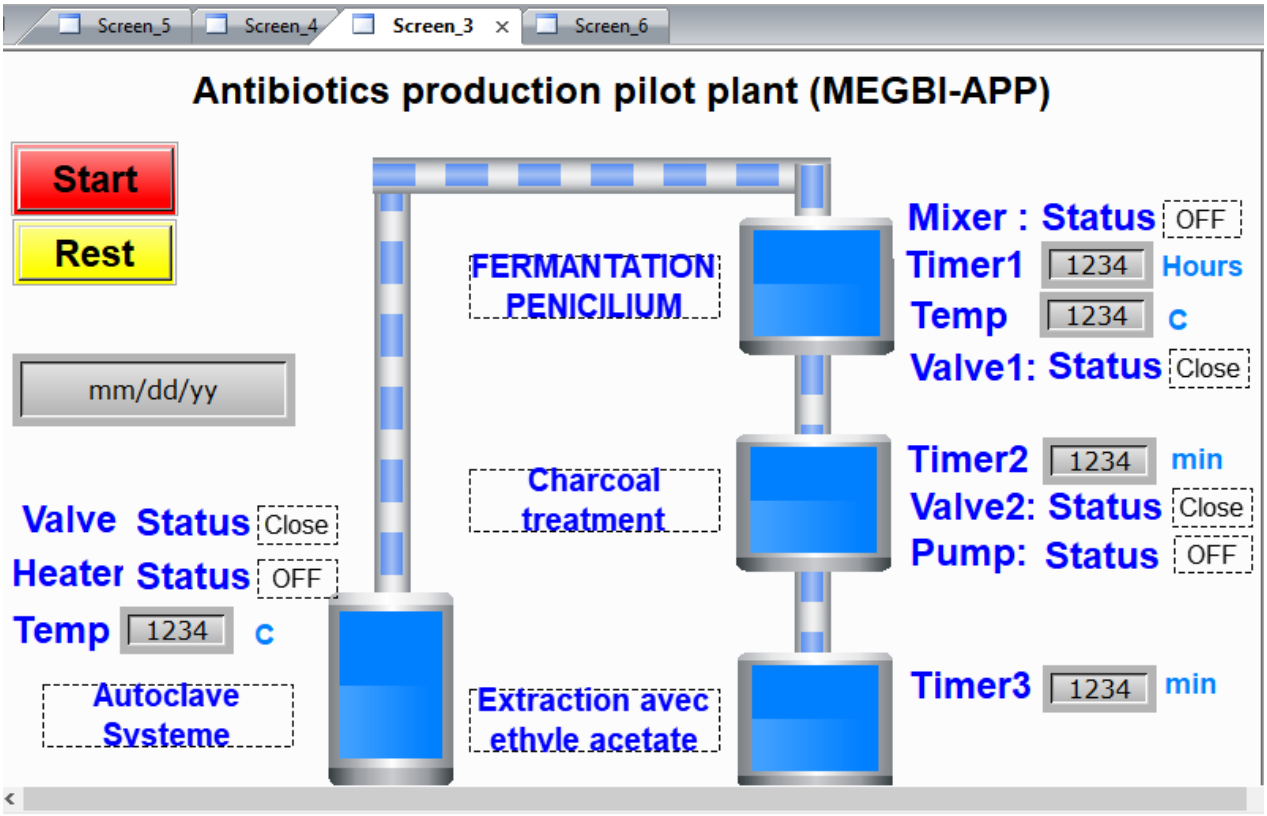
Autoclave system:

a) Heater :
- Press “Manual”
- for OFF Press “Manual OFF”
- for ON press “Manal ON” (if Temperature > 122^0 C Heater OFF)

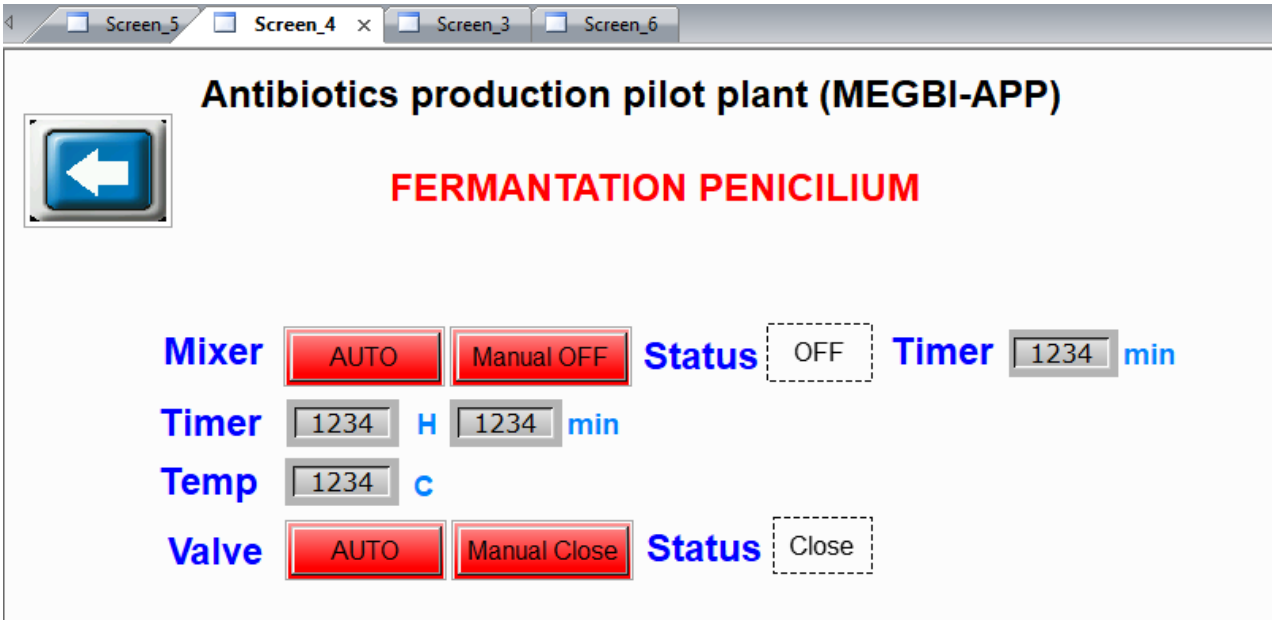
b) Solenoid valve
- Press “Manual”
- for Open Press “Manual Open”
- for Close press “Manual Close”

3.2.3 HMI pages

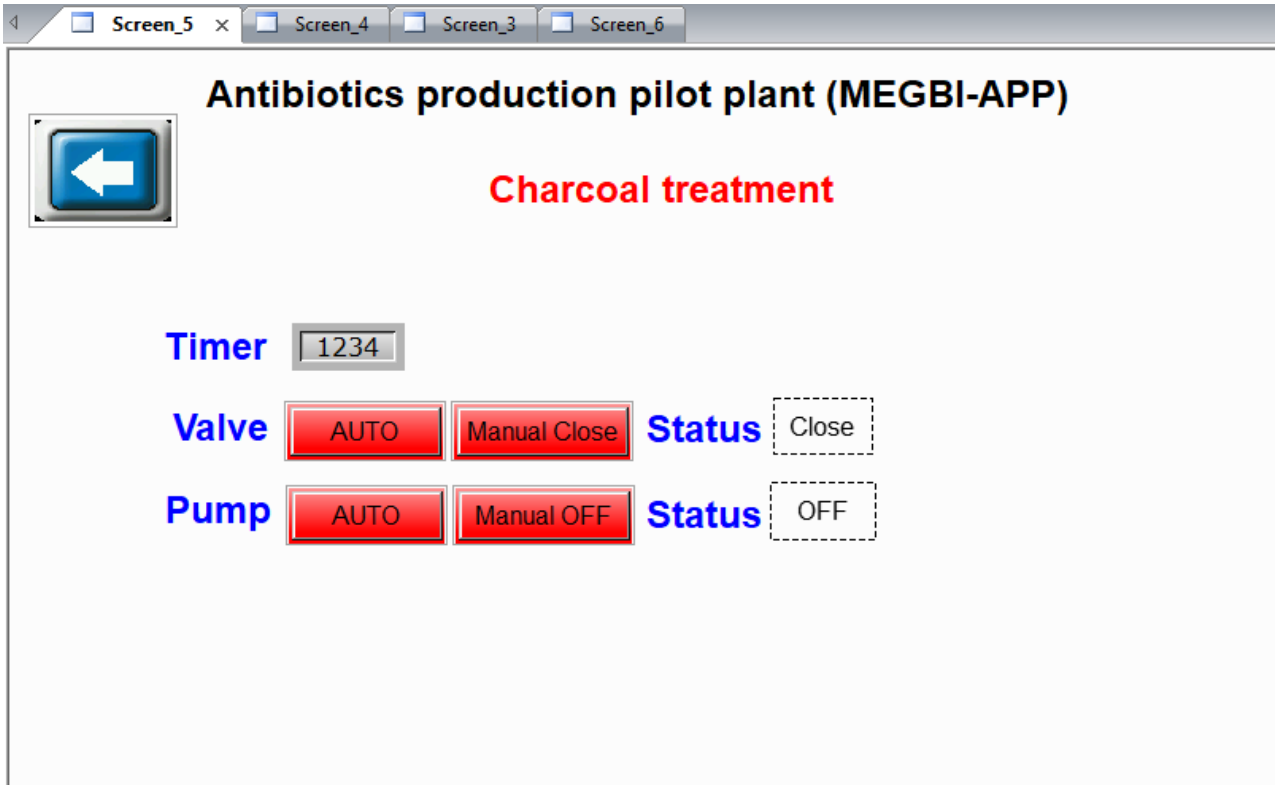
3.2.3.1 Main page



3.2.3.2 Fermentation pencilium page



3.2.3.3 Charcoal treatment page



3.2.3.4 Autoclave system page